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THE DEVELOPMENT OF GERMAN SHIP-BUILDING.

By Rudolph Haack.

I.—HISTORICAL REVIEW.

IN these closing years of the century a backward glance at the events which characterized it may not be without interest. In the very foreground stands the immense advance in manufacturing of every kind and description in every civilized country, both of the Old and the New World. Almost to the very middle of this artificial division of time, manufacturing occupied a very modest rank as a profitable occupation either for individual or nation, but to-day it has passed all others. Many of its subdivisions were then unknown, such for example as the whole division of electric technology; others, several thousand years old, like ship-building, have, during the century now almost gone, become wholly changed, the only thing in common between the past and the present being the production of something which floats, and which by the conservatism of language, is still called a ship. This transformation will at once be recognized when comparison is made between the largest wooden ship of the first decade of the century, and such a ship was the largest thing then made of its kind, with the largest and fastest passenger steamer of the present.

* The series of papers by Herr Rudolph Haack, the former director of the great Vulcan Works at Stettin, of which this is the first installment, form a record of one of the most marvellous engineering developments of the century. The story of the growth of ship-building in Germany will bear studying by both English and American ship-builders, and not by ship-builders only, but by all branches of the engineering profession. The introductory paper which is here given will be followed by three others, copiously illustrated, and telling most fully how Germany has not only shaken off her dependence upon other countries for her own ships, but has also invaded the markets as anindustrial competitor who must be sternly reckoned with hereafter.—THE EDITORS.

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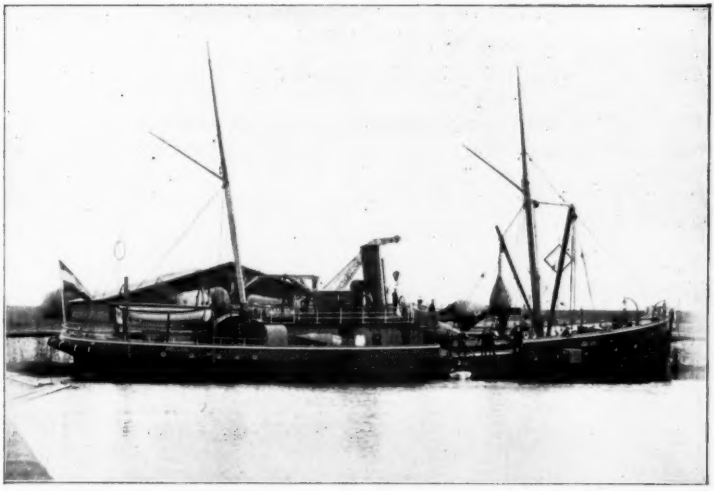
Attempts to supplant wind by steam had already been made early in the eighteenth century, but up to the beginning of the nineteenth no practical success had been attained, this coming only later. The sailing ship was still the only link between countries or lands divided by seas or lakes, and its perfection was the chief aim of ship-builders even into the fourth decade. Wood was the chief material and the only metal fastenings were the nails and bolts.

The equipment of a ship was also composed much more of wood than of iron, examples being the capstans for anchors and cargo, and the wheel for steering gear. Next to the body of the ship came the masts, also of wood, the rigging and sails, whose excellence and adaptation were problems to be solved by the sole director of all, the ship-builder. He alone directed the whole construction, and in well equipped ship-yards there were the shops of the smiths, carpenters and sail-makers, etc., so that outside craftsmen were scarcely employed at all.

How different to-day! The naval constructor is charged with the important duties of designing the lines, of calculating the strength of all materials and trusses, as well as the assembling of the hull of the ship and its compartments; but the construction of the engines with all their details, their installation, trial and operation, these belong wholly to the mechanical engineer. The mental equipment required for each of these departments must be so exhaustive and varied that they are very rarely combined in one man, the duties of each in a great yard being so important and numerous, that it is essential to keep the two divisions distinct, and therefore each is usually under its own head.

Under these heads or masters a whole staff of engineers, specialists, foremen and workmen is employed, to build only the two main parts of the ship, *i. e.*, the hull and the machinery. When this work is done, the design and installation of the many appurtenances and furnishings of the fast steamer of recent years is taken in charge by an army of specialists, machinists, electricians, plumbers, lighters, and many other engineers. Architects, sculptors and painters of renown are charged with the interior and exterior decoration worthy of so great a work, and other masters and workmen of all kinds, such as carpenters, painters, gilders, metal workers, sail makers, rope makers, riggers, etc., must contribute with their skill what appertains to their trades. If we follow construction a further step backwards to the production of all raw materials used in a great ship, there is scarcely a trade or specialty in all the whole sweep of manufacturing industries



BUOY-SETTING STEAMSHIP FOR THE IMPERIAL YARD AT WILHELMSHAVEN.
(Built by Jos. L. Meyer at Papenburg.)

which does not contribute a part either to the ship itself or to its details.

Yet more plainly marked in the difference in cost is the difference in importance to the manufacturing industries between a ship of the first years of the century and of its last years. In former days, both in Germany, and with few exceptions also abroad, among seafaring nations, a bark of five hundred net tons register was a ship of the largest size; the cost in wood, finished, equipped and ready to sail being from $12,000 to $12,500, of which about 60 per cent. went to the hull of the ship and about 40 per cent. for equipment, such as anchors, sails, rigging and all the other movable inventory. The recent fast passenger steamer of the largest size costs about $3,250,000, or 260 times as much as the above specified sailing ship.

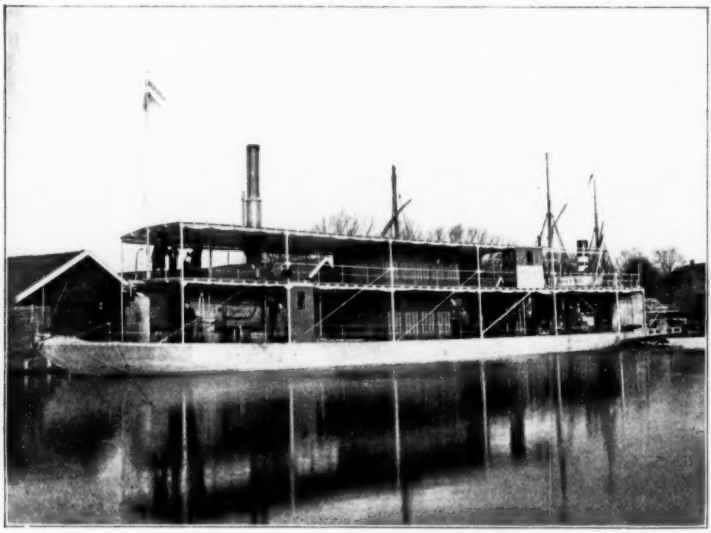
Of this large sum the machinery calls for $1,625,000, the body of the ship for $1,250,000 and the general furnishing and appurtenances about $375,000.

While therefore, a hundred years ago the ship builder directed and completed the building of a ship from begining to end, to-day, in the great and fast passenger steamer, he has charge of only 50 per cent. of the total work, and even then, 11.5 per cent.of the total, or 23 per cent. of his share goes to appurtenances and furnishings The

half of the whole cost the mechanical engineer expends for the powerful machinery to force the colossus along at the tremendous speed demanded to-day.

Naturally in this radical evolution of ship-building, the first of all naval nations led the way. England first built ocean-going steamers, and again it was England who first used iron to drive wood from its vested rights in ship-building, rights which had existed for thousands of years. Soon all nations ordered all their iron merchant steamers from England and many of the naval powers ordered their battle ships from English yards, only a few, like the United States, France and Sweden, building these latter in their own government navy yards. Naturally, therefore, shipbuilding developed to great perfection in Great Britain, and this makes it difficult even to-day for other nations to retain even a part of the enormous sums poured constantly into England for new steamers or for repairs on old ones.

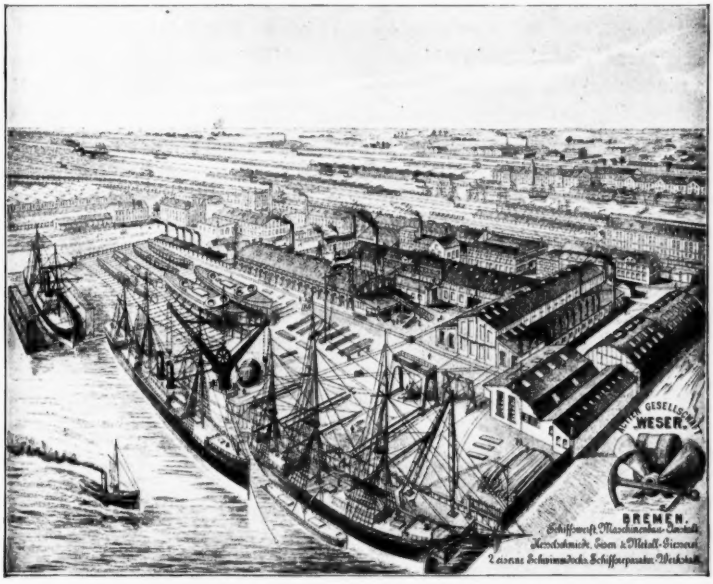
For a long time these conditions prevented German ship-builders from making any progress in their products, and in addition there were other discouragements. Glancing back to the early years of the century we find very disheartening political conditions, checking any development either of commerce or industry on the continent of



RIVER STEAMBOAT FOR SERVICE IN AFRICA.
(Built by Jos. L. Meyer at Papenburg.)

Europe. The all-powerful emperor Napoleon choked all commerce by his continental blockade, and only on American smugglers were the very necessaries of life, both in food and manufactured articles, brought to continental ports from England.

When this obstacle was removed by the triumph of the war of liberation, 1813 to 1815, the internal weakness of Germany and the jealousies between the governments of the many independent states



VIEW OF THE "WESER," SHIPBUILDING COMPANY AT BREMEN.

prevented any rapid growth of commerce and industry. Everywhere means and conditions were lacking for a stronger development, and the absence of any demand for ships left the few ship yards of the North Sea and the Baltic deserted. Not only were there no orders, but the masters and journeymen had gone to the war and many never came back, others were impoverished, and so the whole ship-building industry of Germany lay crippled.

The recovery was very gradual, activity slowly beginning again in the yards and the business being taken up where it had been left before the war, the first ships being in design and tonnage like the older ones. Gradually change was brought about in the North Sea

ports by the great increase of emigration of Germans to the United States, which stimutated especially the passenger business. The new sailing ships were built for greater speed, and the holds, hitherto mere dark boxes for freight, were remodeled for the accommodation of passengers. The merchants of Hamburg and Bremen also began to send out their merchant ships to Central and South America, to West Africa, to Mediterranean shores. These vessels carried German manufactured articles to those countries and brought back tobacco, cotton, etc., and for these purposes larger and larger ships were used. This stimulated the ship builders of the North Sea coast, their profits increased and the yards on the Elbe and Weser became more and more active, so that they were in a most flourishing condition between 1830 and 1850.

The Baltic trade was chiefly confined to that with English ports. Ships exported such German products as wheat and lumber, and returned laden with coal and iron. There were very few houses in the harbors on the Baltic who attempted transatlantic voyages with their ships. Accordingly, on the Baltic, with few exceptions, the ships built were no greater in tonnage than those of the previous period of activity, but the number of yards grew amazingly. Small harbors would have two or three, and even in the villages everybody was shipbuilding. The yards were overrun with orders, and very soon the sailing fleets of the North Sea and Baltic were imposing in importance and number of ships.

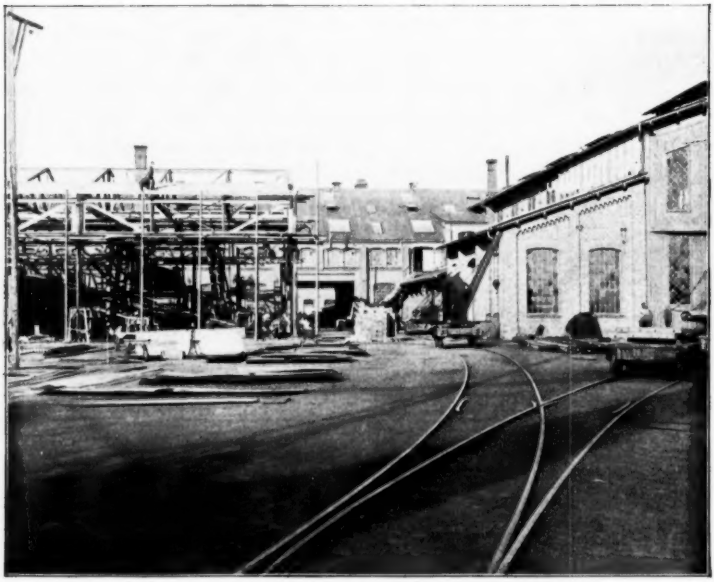
At first abundant supplies of ship timbers were drawn from the North German forests, near the coast, this timber also being exported to France and England. As these sources of supply were exhausted, draughts were made on the forests further inland, and later on splendid oak and fir timbers were brought from Poland and distant Galicia. There was but little use for iron. The few nails, bolts, or bands for masts and spars, came from Sweden or England, and especially copper and its alloys for similar use or for external sheathing below the water line came almost exclusively from England. Hemp for ropes was drawn from Russia, but sails again from England, etc., so that the industry was very dependent on imports of material from abroad. Little by little this dependence decreased and in the fifties, the last decade in which wooden ship building flourished, German industry had made so much progress and freights had been so reduced that nearly all essential supplies were drawn from German sources.

The mastery and direction of a ship yard in those days was generally in the hands of its owner, a master ship-builder, who, according

to the customs of the time, had been obliged to prove his knowledge and skill. He had to serve as apprentice and journeyman for a legally determined number of years, and only became a master ship builder after passing the required examination. This was a very mild strain. The tests proposed were the building of a sailing ship and an estimate of cost for a special design. There was in addition a verbal examination in which a few questions had to be answered as to the method of work, rigging, etc. Any experienced ship builder could teach the trade to any competent, steady, and reasonably intelligent apprentice or journeyman. The desire for greater experience and higher theoretical skill led many who hoped to become masters to go abroad to acquire there this greater knowledge. The ship building school in Copenhagen under the direction of the engineers of the Danish War Marine, gave advantageous opportunities, and also in Sweden there were teachers who were specialists in theoretical ship building. To these countries many young German masters journeyed to perfect their knowledge. Later on, in the Hansa cities, Hamburg, Bremen, etc., private schools were started for eager young ship builders, and

STEAMSHIP "CERES."

(Built by the "Weser" Shipbuilding Company for the Neptune Steamship Company.)



YARDS OF THE "WESER" SHIPBUILDING COMPANY, BREMEN.

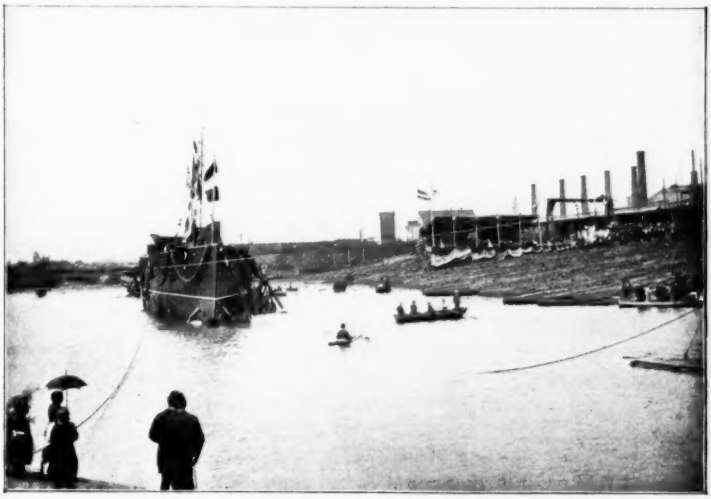
near Stettin, in the thirties, the Prussian government founded a school in which there was a preparatory course in higher mathematics and a full course in construction and theory of ships.

This scientific training acquired by the managers of the larger yards, united with the practical experience gained in years of work by the masters and journeymen, led to very great perfection in the building of wooden ships in Germany, and when in the United States the splendid clippers were built, many prospective master ship builders seized the chance to perfect their skill in American yards, and the effect was soon seen in the large sailing ships of clipper build launched between 1850 and 1860 in Bremen and Hamburg.

Shortly before this period on some of the German rivers a few steamboats were carrying passengers, or were acting as tug boats. At first they were built wholly abroad, later the machinery alone was imported and fitted in wooden hulls of German production. But in England and America energetic attempts were making to substitute steam driven paddles or screws for sails, on sea-going vessels, and these efforts had met with such practical success that steamers were substituted for sailing vessels, both for passenger and express freight busi-

ness. Built of wood, after almost identical models, and on almost identical lines, equipped with masts, rigging and sails, these steamers closely resembled their wind-driven prototypes. The chief difference in appearance was caused by the paddle wheels and paddle wheel boxes.

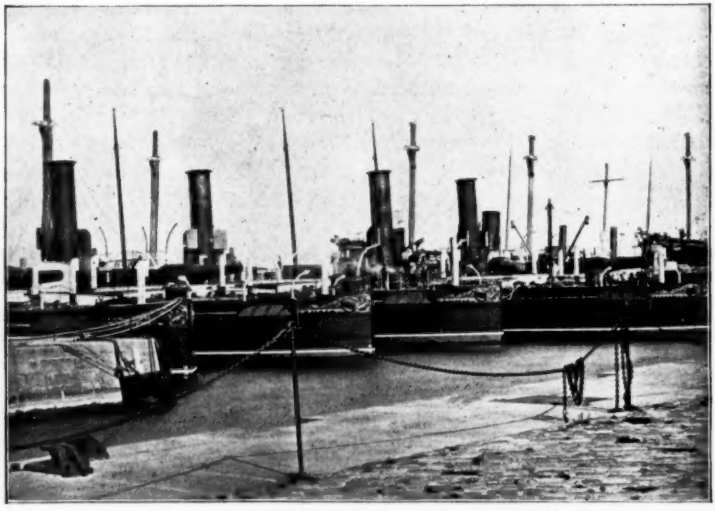
Between 1840 and 1850 England had already begun to build iron ships, and this industry grew very rapidly and as a consequence laid waste the German yards. A very few managed to exist on repair work, and fewer yet with large capital and favorable situations were transformed into yards for the construction of iron ships. Together with a few new yards on the North Sea and Baltic coasts, started solely for building iron ships, or developed by additions to already existing machine shops, they all suffered from paresis and England captured all the orders for new steamers of large size. Small steamers of small profit to builders were ordered in Germany, and this forced the existing machine yards either to turn their establishments into other lines of manufacture, or in the case of new plants to neglect ship building for other branches of iron work. Even when Prussia began to develop her war fleet, after 1848, very little benefit accrued to private yards. The wooden hulls, excepting those of steam gun-boats and for the corvette *Danzig*, were built at the Government navy yard in Danzig, and the steam engines were orderd from famous British



LAUNCH AT THE "WESER" SHIPBUILDING COMPANY'S YARD, BREMEN.

yards, whose experience in such matters was so far ahead of that of Germany. To give this necessary practical experience to German engine builders, they were given the orders for the little gun-boats and later on they were intrusted with the building of the engines for corvettes, etc.

Shortly before 1870 the government naval authorities established at Kiel and Wilhelmshaven yards for the repair and also for the building of large battle-ships, especially for the ultimate purpose of building all the new navy either in these new yards or at Danzig. When



ARMOURED GUNBOATS.

(Built by the "Weser" Shipbuilding Company.)

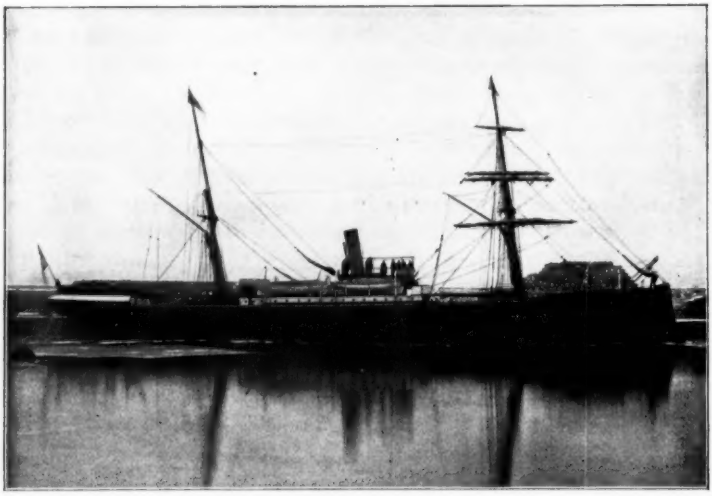
however, after the war with France a German fleet of home manufacture had to be created rapidly, the capacity of the government navy yards was overtaxed, and the private yard "Vulcan" at Stettin received the order for the building of the armoured frigate *Preussen*, the armour, however, not being included in the order, as this was reserved for the government yard at Kiel. This order marks the date of the revival, one might almost say the beginning, of modern German ship-building, for this private yard "Vulcan" succeeded in executing this large order so quickly and satisfactorily, as well as that for the armour plating of the iron clad *Preussen* and the building of the armoured corvette *Hansa* that it won the entire confidence of the Imperial Ad-

mirality and gave proof that the plans and designs of German naval engineers even for the largest battle-ships of that day could be executed in Germany, thus removing the hitherto almost ineradicable mistrust of home yards.

This much coveted success did not however have the wished-for influence on the great steamship companies of Germany. From 1855 on, the steam fleet of the Hamburg Packetfahrt Company, and of the North German Lloyd grew rapidly to positions of the first rank, but only a few of their smallest vessels came into existence in German yards. Still in 1880, when the latter company prepared to order the first of the fast steamers, the directors requested tenders from German yards as well as from British firms. The former, hoping to have long deferred expectations realized, held out extraordinary inducements to secure the contract but nevertheless it went to Fairfield, because the majority of the Board believed that the German yards could not give as trustworthy guarantee of reliable work as their British

TORPEDO BOAT SUSPENDED FROM CRANE.

("Weser" Shipbuilding Company. Bremen.)



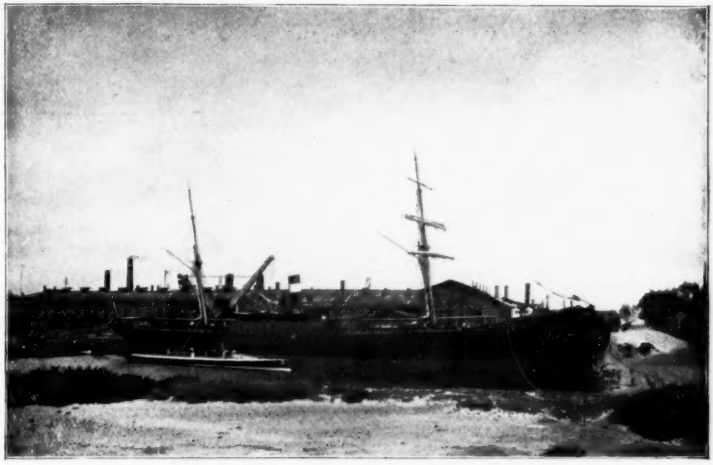
PERSIAN STEAMSHIP "PERSEPOLIS."

(Built by the "Weser" Shipbuilding Company, Bremen, 1884.)

competitors. The Hamburg Company had not been quite as conservative and had ordered small vessels since 1873 from the yard of Blohm and Voss in Hamburg, from the North German yard in Kiel, and, in 1879, from the Flensburg shipyard. The urgent request of the Minister of Marine von Stosch was however necessary to induce the Board to give the orders for the two largest passenger steamers built in Germany before 1882, the *Rugia* and the *Rhätia;* the first to the "Vulcan" at Stettin, and the second to the Reiherstieg yard at Hamburg. Both orders were executed to the fullest satisfaction of the Board, but the ice was only really broken in 1886 and 1887 when the "Vulcan" at Stettin, delivered to the North German Lloyd in Bremen six imperial mail steamers, subsidized by the government for trips to Eastern Asia and Australia upon the express condition that they should be built at home and of German material. These steamers, which complied with all specifications, proved that in Germany shipbuilding had reached the same grade of excellence as in Great Britain, and from that time forward further orders were given by both of the two great transportatoin lines to the "Vulcan," as well as the other large yards, as that of Blohm and Voss, Reiherstieg and others.

Important triumphs had also been scored with the delivery by the

"Vulcan," of the battle-ships *Preussen*, *Sachsen* and *Württemberg*. The imperial navy yard had built the *Friedrich der Grosse* and the *Grosser Kurfürst*, sister ships of the first of the above mentioned vessels, and with the help of the Danzig yard also built the armoured vessels *Bayern* and *Baden*, *Hansa*, the cruiser *Alexandrine*, and others. The "Vulcan" built the corvettes *Leipzig*, *Prince Adelbert*, *Stosch*, *Stein*, *Carola* and *Olga*. In the "Germania" yard at Kiel, belonging to the Weser Company corvettes of the type of the *Bismarck*, small armoured vessels for coast defence, the imperial yacht *Hohenzollern*, and others were built. Schichau at Elbing was specially distin-



STEAMSHIP "AUSTRALIA," 3,000 TONS BURDEN.
(Built by the "Weser" Shipbuilding Company, Bremen, 1884.)

guished for light and rapid torpedo boats, and the knowledge and experience gained by the managers, designers, engineers and workmen of the private yards in executing all these orders for different kinds of steam craft were recognized by foreign governments, so that on every side foreign orders for battle ships poured into the German yards.

China ordered of the "Vulcan" two armoured vessels and three protected, partly armoured cruisers, besides many torpedo boats. Russia ordered from the Weser Company two small cruisers. Spain ordered a torpedo boat. The Germania Company obtained contracts and built men-of-war for Turkey, Spain and Brazil. The Schichau yard received many orders for torpedo boats from many foreign gov-

LIGHTSHIP BUILT BY THE "WESER" SHIPBUILDING COMPANY, BREMEN.

ernments of Europe, Asia and America and the Howaldt yards at Kiel built two cruisers for China.

The latest German products of shipbuilding are in every respect, both in design, construction, quality of material and perfection of work equal to the very best done in British, American and French yards.

The best proof of this is the fact that in addition to renewed orders from the foreign governments who had already favored German yards, other governments like Russia and Japan, who thus far had ordered nothing larger than torpedo boats now began to order battle-ships. Through the satisfactory filling of these orders the good work goes on, yet the very highest pinnacle of success and fame was reached in the fast steamer *Kaiser Wilhelm der Grosse,* which now, for more than a year, without long trial trip and without interruption, has made steady runs between Bremen and New York with the highest record of speed ever reached by this class of vessel. With the single exception of the Great Eastern it surpasses in size any steamer ever launched, and even greater results are expected from the *Deutschland* now building at "Vulcan," although the recently-launched *Oceanic* at Belfast surpasses it in dimensions.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

VIII.—ELEMENTS OF A MODERN MACHINE SHOP (Concluded).

IN concluding the discussion of the requirements of a modern machine shop, the enumeration of the essential elements will be completed and some general conclusions drawn.

Foundry. This is, of course, a distinct organization in itself, and it will be mentioned only as a desirable adjunct to a machine shop which is large enough to support its own foundry. The importance of a thorough control of the foundry, with a view to producing castings of such a quality that work will be saved in the shop and the cost of machining and tools will be reduced as much as possible, is now fully appreciated by most machine-tool makers. Europeans, however, must pay far more attention to their foundry practice than at present, in the way of turning out more accurate castings, pickling, annealing, using the right raw material, etc., before they can compete either in price or quality with the castings usually found in the American machine tool.

Laboratory. It is remarkable what a long-suffering victim the machine shop has been simply because it has not made use of any scientific methods to check the mysterious workings of iron and steel makers. The laboratory should be an auxiliary to the machine shop, the value of which is, I believe, not yet recognized by any machine tool maker, either European or American. It is, however, to be thoroughly tried by the Loewe company, who are fitting up a laboratory adapted to machine shop requirements, for the chemical and physical testing of all materials which enter into the construction of a machine tool. The results will be watched with interest by all machine-tool makers, and it is hoped that the laboratory will be of use in determining the exact specifications of material, particularly of that used in cutting-tools.

It will be noted that the production of small tools, which is undertaken by many machine-tool makers, has received no consideration in the arrangement here set forth. The fact is that practically the same organization is necessary for the manufacture of small tools as for machinery, with the difference that the parts can, in most cases, be produced in larger quantities, and, of course, the machinery and tools

are materially different. At the same time, they are not, as a rule, made in sufficient numbers to warrant a special plant for the production of each article like a reamer, counterbore, tap, die, etc. Nearly the same departments would be necessary as for making machine-tools, but the work is so entirely different that it is out of the question to combine it with the production of machinery. The methods which should be followed would largely depend, of course, on the size of the works. In any case, a special department should be arranged devoted wholly to the production of small tools, whether on a large or a small scale. If on a large scale, a special factory building with separate engineer's organization and plant would be desirable.

It would be impossible, in the limits of the present article, to enumerate the best appliances and machines to be used in the departments mentioned, or to speak of the designs of the various fixtures and fittings. It is possible to arrange most of these departments even in the older factories not specially designed with a view to this particular organization, although, of course, it would be more difficult to produce machines as cheaply in such works as where the design of the buildings or factories harmonized with the organization described. As many other factors are necessary for consideration in arranging a modern machine shop, apart from the organization and equipment, it would be well to state briefly other items which should receive particular attention, such as

1. Method of transmitting power.
2. Transportation of parts.
3. Flooring.
4. Heating, ventilating and lighting.
5. Accommodation for workmen.
6. General fittings.

Transmission of Power. Within the scope of this paper it is not possible to discuss the economy of any system of transmitting power. It is generally admitted, by those who have had occasion to design shops within the last few years, that electric transmission has immense advantages over any other method. In many cases, separate machines can be arranged with independent motors. Groups of machines, run by one motor, operated quite independently of the rest of the factory can also be arranged. Large driving belts, which take up factory space, and are always a source of annoyance and expense, are thus done away with, but the greatest advantage of all is where entirely new works have to be designed. In this case electric transmission adapts itself to any form of building whatever, or to any group of buildings which may be deemed advisable. It is also possible, where electric

drive is properly installed, to take exact readings of power consumed in individual cases. For some of the above reasons, the electric transmission of power is largely in favour. Respecting other details of transmission, the proper form of hangers and bearings, and sizes and speeds of shafts are worth careful consideration to any manufacturer, as the amount of power consumed by a badly arranged transmission can never be accurately calculated. Roller bearings are the latest innovation for the saving of power, and remarkable results in transmission have been obtained in some cases by their adoption. Now-a-days no one would think of putting in anything but self-oiling and self-aligning bearings. Particular attention should be given to a practical method of securing countershafts and main shaft hangers, on account both of the saving in erection and of the changes constantly occurring in the location of machines.

Transportation of Parts. With respect to the above items, the old factories are at a decided disadvantage compared with the newly arranged machine shops. For the transportation of parts is a serious consideration to any manufacturer who must continually handle heavy pieces of metal. The appliances and labour-saving devices are numerous, and they have received far less consideration from machine tool makers, either American or European, than from manufacturers of other articles. I know of no machine shop which is perfectly equipped with reference to the transportation of parts. Some of the elements that should receive consideration in this department may be here enumerated. Electric traveling cranes, running at high speeds, are, of course, an important factor. Quickly operating hoists on runners or hand cranes are also extensively used; the air hoist seems to be the most economical for this class of work, although few old factories can avail themselves of its use, as considerable height is necessary for the simplest working form of air hoist. That which is most seriously neglected in transportation of material, however, is, what may be termed the industrial railway, which is so thoroughly developed by the C. W. Hunt Co., New York. By an extensive system of factory rails, with properly designed trucks, immense savings can be effected. One man should be able to convey to any part of the works weights or loads up to a ton, but where there are no special facilities, four or five men would be necessary to transport the same load. As a labour-saving device, this internal railway receives far too little attention from manufacturers..

Flooring. An item that has received careful attention from American machine shop constructors but seems to be looked upon by

Europeans as merely a structure for supporting loads. It seems that in Europe the design of machine-shop floors is usually left to architects who have no appreciation whatever of mechanical requirements. To make a floor which is true—so that machines can be easily levelled up and will remain in alignment,—to which light machinery can be easily fastened, which is cheap to repair, which is kept clean easily, and still is not dusty, which is not affected by oil, is durable, warm and not too expensive, is possible. The desirability of fulfilling the above conditions cannot be disputed, but this is not realized in European shops. Proper flooring is, however, one of the essentials in machine shop equipment which is of material assistance in producing good machinery; it is a valuable aid in maintaining order and cleanliness.

Heating, Ventilating and Lighting. To secure the greatest comfort and the best surroundings for workmen is, as almost every manufacturer will admit, a paying investment; at the same time, the practical value of these accessories is scarcely ever fully realized. They receive far more attention in America than in European countries. The health of workmen is of first importance, and by the absence of discomforting and distracting surroundings their efficiency is increased. Will any manufacturer contend that good work can be produced for a reasonable price in dark, cold and badly ventilated shops? Lofty, well lighted, comfortably heated and ventilated workshops, then, are important factors in the production of a machine tool. Heating alone is an important item, and a well heated factory can be easily and cheaply equipped if a proper system is installed. It seems that there is no system which meets the requirements of a manufacturing establishment so fully as that of the forced warm air blast, such as has been developed by the Sturtevant Engineering Co. and others. Its advantages are absolute control, ease of manipulation, it is thoroughly effectual and gives the best of ventilation, as the fresh heated air can be steadily supplied in the cold weather and a constant stream of fresh air can be introduced into the various departments in the hot weather.

Electric light, in various forms, is rapidly displacing all other methods for factory purposes; it is much safer, more easily manipulated, and does not pollute the atmosphere like gas. In order to secure all the daylight possible, windows must be large, rooms must be of the right height and width with reference to surrounding buildings, and, where top light is used, there must be plenty of glass surface. Ribbed glass is very satisfactory as a means of diffusing light; it has many advantages, and is sure to be widely adopted.

Accommodation for Workmen. As a means of securing and retaining the best workmen, the best appliances for their accommodation and comfort become, of course, a necessity. To maintain order, cleanliness and discipline is impossible with inferior arrangements for the personal comfort of workmen. It is hardly reasonable to expect a high state of efficiency in a combined machine shop, wash room, wardrobe and eating house; this is the combination found in the ordinary machine shop. It is an uneconomical use of shop space to occupy it with wash basins and clothes cupboards. To give the best accommodation to workmen, and to secure the best shop organization, necessitates the separation of everything pertaining to the personal wants of employees from that which has to do purely with manufacturing. Closets can be arranged so as not to encroach on shop space and still be convenient; it goes without saying that they should be well fitted and so designed that they can easily be kept clean and under control. The advantages of having good cellars (not to be used as work rooms) under a machine shop are so numerous that they need not be enumerated. The most important use for cellar space is, undoubtedly, for commodious washing facilities, combined with wardrobes. From no other point can men so quickly reach all departments as from the cellar. The moral influences of good accommodation in the above respects are valuable, as these comforts are inducements which assist in retaining desirable and in weeding out indifferent men. As far as I know, no machine shop has tried the experiment of supporting a restaurant, and of giving the men a good mid-day meal, free of cost to the employees. I am strongly of the opinion that free dinners would be a paying institution. In European shops where the standard of living is, amongst employees, lower than in America, a good dinner could easily be supplied at a cost of six pence, or fifty pfennigs per head. If free, this would be equivalent to increasing the pay of each man by the cost of the meal, with the certainty that that portion of his wages was used for the material welfare both of himself and of his employer, and was not devoted to beer, which does not nourish but incapacitates. To a machine shop of any considerable size, I look upon a restaurant as an element worthy of consideration.

General Fittings This would include all factory fittings which facilitate the handling and control of work that is in process, and the distribution and care of tools and fixtures. Tool rooms should be well arranged, and located conveniently for the distribution of supplies. Benches, racks and cabinets should be properly designed and

situated. This item, if it receives due attention, will be found complicated and extensive. It has an important bearing, if order, cleanliness, and good organization are desirable.

It finally remains to mention accounting and cost keeping as the one element which unites all others into a complete organism. Its object is twofold: to maintain orderly progress in the process of manufacture, and to record information which is exact and easy of access. As such it is of material importance in keeping up a standard of excellence, and in reducing the cost of manufacturing. It is more generally made use of, and is more thoroughly developed in America than in Europe. This subject has been exhaustively and interestingly discussed by Mr. Roland in recent numbers of THE ENGINEERING MAGAZINE.

It will be seen that the various items have been but briefly dealt with. In planning a new machine shop, or in re-organizing an old one, all the elements which have been enumerated must be dealt with, whether the shop be large or small. How they should be grouped, expanded or contracted depends upon the size of the factory, and the variety and character of the product. The ideal to follow is to have the product continually moving in one direction—going in at one end of the building in a raw state and coming out at the other as a finished article. This principle, if followed, admits of systematic organization, and reduces the cost of transportation to a minimum. In designing a building for a modern machine shop, the building itself may be considered as the frame work of a large machine, in which all the smaller parts are to work. Architectural design must simply follow the dictates of engineering requirements. But a brief outline can be here given of those items which should receive particular consideration in planning entirely new works. First and foremost, it should not be forgotten that each department must be a specialty in itself, as far as possible, with special equipment, special foremen and trained workmen who are, in a measure, entirely independent of any other department. This is but the sub-division of labour, and in order to get the full benefit of specialization, it will be found that the best plan is to have departments entirely separated from each other, and to have as little communication between the workmen of the various departments as practicable. The form of building should be such that, having due regard to other conditions, the proper divisions are possible. It would appear that the wing construction best fulfils the above requirements, as it gives the best light while taking up the least space. It seems entirely unnecessary for machine-shop work to go to the ex-

treme of having everything on one floor, except where heavy machines exclusively are made, as it is highly desirable for a great deal of machine work to have side lights. For the transportation of heavy parts, overhead cranes necessitate a peculiar form of construction, but this can be readily combined with the wing design, so that the transportation can be easily carried on.

The manufacturer who seeks to satisfy his customer with speedy deliveries will not fail, in planning new works, to give due consideration to shipping facilities. Here the system of transportation should receive its final touch. Economy and dispatch are a satisfaction to all concerned in handling the finished product of the modern machine shop.

First, last and always, should manufacturers, especially those who are to erect new shops, remember that it is economy as well as humanity to plan factories " in which human life is of more account than machinery"; into which human beings will not be driven by hunger, but attracted by superior hygienic surroundings, air, light, comfort, as well as by the most modern equipments for saving labour, increasing output and raising the standard of workmanship and wages. Specialization is an economic necessity. How to mitigate the incapacitating effects of routine work is one of the coming industrial problems. The least that capital can do at present towards solving this problem is to erect rational workshops.

THE ENGINEER AND THE ROAD TO THE GOLD FIELDS.

By Harrington Emerson.

HE who leaves Seattle for the Klondike and the Alaskan gold fields, enters another world when he boards the north-bound steamer It is not that the vessel differs from steamers of the same tonnage on the Atlantic Coast, for the engineer's handiwork must be more perfect for voyages to the outlying places of the earth where there are no repair shops. It is the passengers who make a different world, or perhaps it is fairer to say that among them the conventions of civilized life lose their force, and the sordidness and other elemental and unlovely instincts which civilization hides but does not eradicate, crop up unblushingly.

A good part of the men northward bound are miners, animated not by patriotism nor hope of homestead, not by dream of glory nor love of science, not by pride of conquest nor religious enthusiasm, not even by the pleasure of adventure, but impelled northwards solely by lust of gold. Dogging the footsteps of these pioneers is the motley horde of human parasites and beasts of prey, both male and female, and these and their ways emphasize the difference between the lust for gold and the pursuit of immaterial riches. No one tries to rob Dewey of his laurels nor Nansen of the honor due his adventures and discoveries, but if a man has secured an ounce of gold a thousand rise up in his path and try to take it away from him.

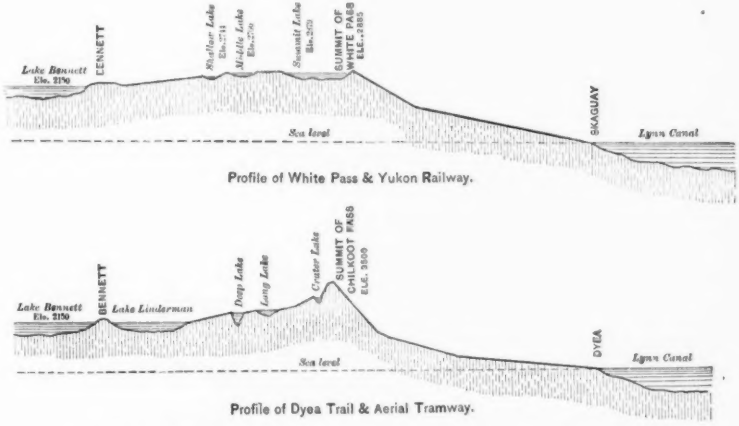
Owing to the absence of parasites, industrial, criminal, and governmental, it was cheaper and safer to go to the Yukon ten years ago than it was when the great work was on, and were it not for the works of the engineer, the passage down or up the Yukon would to-day be lined with as many robber roosts, levying blackmail, euphemiously called toll, on all the travel and traffic, as was the Rhine in the Middle Ages.

But the engineer, with his ocean steamers, wharves, railroads, aerial cableways, riverboats, etc., came and converted what was once an expedition of extreme physical danger and hardship, and what next became a journey of extreme pecuniary danger and expense, into a rapid, safe, convenient and also cheap trip to the Arctic Circle. It is this cheapness that above all else will develop the resources of that

far off region, making profitable great numbers of mines to-day unworkable.

In California, gravels containing as little as five cents of gold to the cubic yard are washed at a profit, but in the Klondike region all gravel that yields less than fifteen dollars per cubic yard is mined at a loss. It is too much to expect that far northern gravels can ever be worked as cheaply as in California, but it is not too much to expect that with cheaper labor, cheaper supplies, and above all, better appliances, five dollar gravels will in time have value.

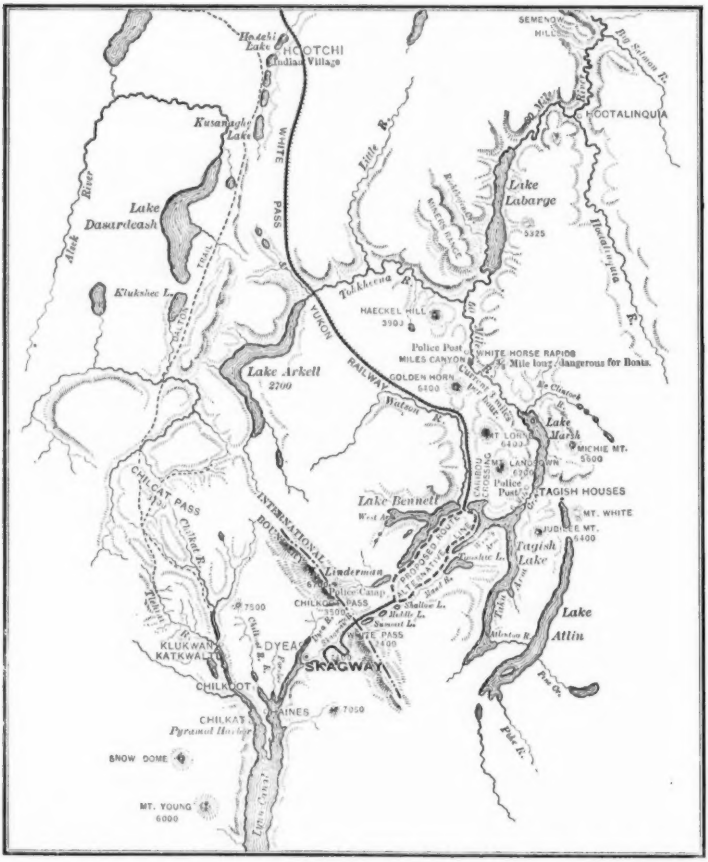
The most remarkable part of the long road to the new gold fields is the short link which crosses the backbone of the continent. Else-



PROFILES OF THE TWO ROUTES FROM LYNN CANAL TO LAKE BENNETT.

where, the continental divide lies in Colorado, Wyoming, Idaho, but in southeastern Alaska, it is a rampart rising direct from the sea. At its base lie the blue waters of an arm of the Pacific. Fourteen miles inland is the summit and immediately beyond are the head waters of the Yukon. A few coast passes are the only feasible highroads to the interior, and this gives them very great political as well as commercial importance. Further north between the Yukon and the ocean are those stupendous snow giants Mount Saint Elias and Mount Logan, towering above 18,000 feet in height.

The profiles showing the two lowest passes from ocean to river were drawn from his own surveys by Frank Reid the engineer, who, at Skagway, Alaska, in 1898, in the cause of decency, order and law,

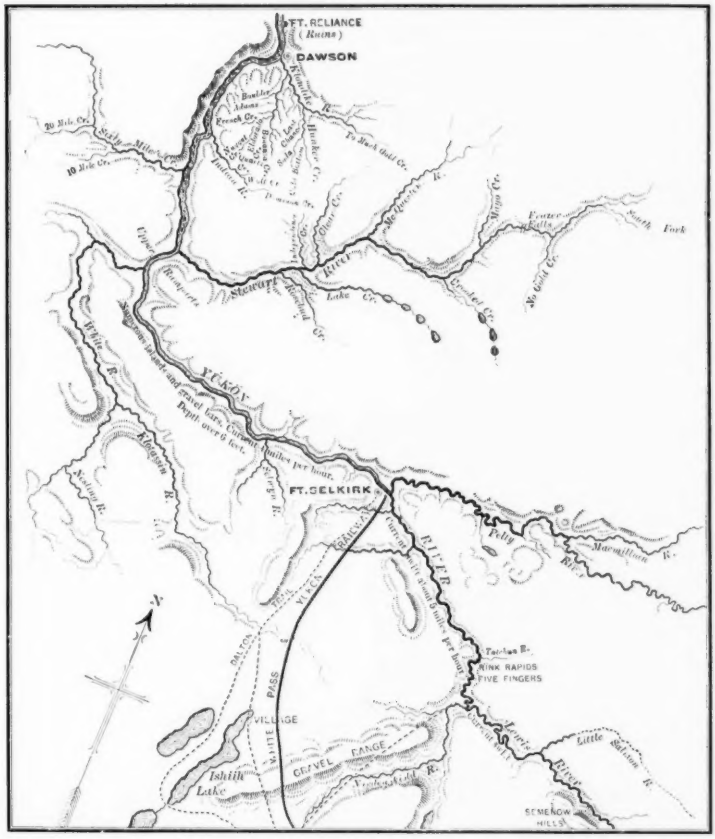


ROUTE OF WHITE PASS AND YUKON RAILWAY FROM SKAGWAY TO FORT SELKIRK.
(Part I., from Lynn Canal to Semenow Hills.)

shot and killed "Soapy Smith," the leader of all the crooks and thugs with which the place was infested, and was in turn killed by him.

Of all the many dead claimed by the dangers and diseases of the murderous trails, Frank Reid alone rests under an imposing monument, erected in the forlorn little cemetery to show the gratitude of the citizens and as a permanent warning to evil doers.

The *man* was honored who had saved the town from a reign of terror, but the *engineer* began a greater work in his surveys which



ROUTE OF THE WHITE PASS AND YUKON RAILWAY FROM SKAGWAY TO FORT SELKIRK.

(Part II, from Semenow Hills to Dawson.)

were the beginning of a development, that, in eighteen months replaced the Indian hunter's foot-path with aerial cableways and a steam railway.

The profiles are worth studying. Lynn Canal is an inlet or fjord of the Pacific Ocean, and the lakes over the summits are the head lakes of the Yukon River. Although these summits are but fourteen miles from the ocean, the distance down the Yukon to Bering Sea is two thousand miles. Nowhere else in the world are the navigable head waters of a great river so near the same ocean into which it finally

WHITE PASS ABOVE THE FORD.

AT THE FORD, SHOWING SUMMIT OF WHITE PASS.

empties. It is as if the headwaters of the Ohio River were but fourteen miles from New York Bay.

From Panama to the Fuca Straits there are but few harbors, but from Puget Sound northwards a whole coast system of mountains and valleys sank, in a former geologic age, several thousand feet, and thus formed the present sounds, canals, channels, inlets, bays, harbors, a land locked water-way of marvelous beauty—and danger—stretching a thousand miles north of the sound cities, Tacoma, Seattle, Victoria and Vancouver. So smooth and placid is this water-way that Indians, in their dugouts, undertake trips of one thousand and more miles along the coast, yet so dangerous is it that scarcely a week passes without some steamer striking or stranding on the dark shores or sunken rocks. At the northern end of this inside passage and ninety miles from the sea is the head of Lynn Canal, which is seven miles wide and from 135 to 413 fathoms deep, but the Wrangel Narrows, a hundred miles further south, are only a quarter of a mile wide and eighteen miles long, and so shallow that rarely a steamer passes through them without scraping on the bottom. At another point in the long inside passage conflicting tide currents swirl and rush thirty miles an hour, and this place can only be passed at slack water, either high or low.

At the head of Lynn Canal is Dyea Inlet, fourteen miles long and but one mile wide, and into the head of Dyea Inlet empty the Dyea and Skagway Rivers, each making a long mud delta covered at high water, bare at low tide; and here the tidal range is very great, sixteen or more feet.

The Dyea and Skagway Rivers both flow rapidly down from the summits of the coast range of mountains. They are but torrents, only fourteen miles long from source to deltas, and within a few feet of their head waters are the head waters of the Yukon; thus natural passes are formed from the coast to the interior. By no other route is the distance so short as up the Dyea River. There has always been an Indian village at Dyea, which is doubly favored by being at the extreme head of ocean navigation and nearest to the series of lakes, Crater, Long and Deep, which empty directly into Lake Lindeman. This lake in turn empties into Lake Bennett, which is but forty miles from Dyea. From an engineering point of view the Skagway route is the better, as the White Pass at the head of the Skagway River is six hundred feet lower than the Chilkoot Pass, but neither Indians nor miners used it. Its series of lakes, Summit, Middle and Shallow, are separated from Lake Bennett by a high divide and flow by long and

THE AERIAL CABLEWAY OVER THE CHILKOOT PASS.

shallow streams into other lakes not so immediately available for reaching the Yukon.

Although the distance to Lake Bennett is the same by survey over each pass the most enthusiastic backers of the White Pass route have always considered it at least ten miles longer, owing to its extreme and lasting difficulty, for foot and horse travel.

In former years at two seasons of the year only was travel possible over the Chilkoot Pass, in late winter when the snow was hard and the lakes frozen, and in late summer when the lakes were open for rafts and canoes.

It is strange that this easy and natural highway for the Indian up the coast in a canoe, over the pass with a pack on his back and down the river on a raft, should have presented almost insuperable obstacles to civilized travel. The Indian in his dugout cared not for narrows, shallows and currents, tides and flats. He did not try to force them but accommodated himself to conditions as he found them, and was governed by the seasons in his trips over the pass, as was also the early gold seeker, who, drifting north in 1877, made his way with Indian help over the Chilkoot Pass to the Yukon River.

Between the final triumph of modern engineering, the railroad, and the natural highway of the savage, there were many stages of improvement which were more toilsome, dangerous and expensive than

the conditions they are supposed to better. There was no longer easy and sympathetic acquiescence in nature's whims when the great gold rush to the Yukon began in August, 1897.

Just as the engineer has substituted his works for all other instruments or vehicles of transportation over the White Pass, so also it is the engineer who with his ocean steamers has supplanted the Indian canoe, the sailboat, the little coast steamers, but with the difference that whereas the land engineer makes his own road on which he safely runs his engines, the naval engineer can only build a good steamer, which too often is wrecked owing to the culpable negligence of a government, quick enough to install revenue collectors, but exceedingly slow to chart, buoy and light dangerous channels.

Nearly five thousand people a month make the passage from Seattle and other Sound Cities to southeastern Alaska, and many thousand tons of freight are also carried, yet aside from a few buoys in Wrangel Narrows there is absolutely nothing provided by the government to aid the mariner in navigating those waters. The Canadian government, both on land and sea, is more prompt to act and to provide protection. It has a light-house on the Sister Rocks in the Gulf of Georgia, another at Cape Mudge at the entrance to Discovery Pas-

THE LAST CLIMB TO THE SUMMIT OF CHILKOOT PASS.

sage and yet another at Egg Island. The disastrous wrecks almost without exception have occurred in United States waters.

As canoes gave way to ocean-going vessels in these unbuoyed and unlighted channels, the government pilot charts were improved with pasters suggesting that the chart was not more than five miles out of the way. Steamer after steamer was lost, the Mexico sank in August, 1897, on her return trip from carrying the first load of gold seekers, the Corona stranded in November of the same year, the Clara Nevada ran on a rock and burned or blew up with a loss of all on board in the

SUNSET ON THE YUKON.

following February, and since then a dozen other steamers have either grounded or been totally wrecked. These dangers and losses continue to date. On February 15th, 1899, the Humboldt, a fine California steamer, went on the rocks between Juneau and Wrangel, and was in gravest danger; early in March the Dirigo stranded but was finally dragged off with severe damage; later in March the Tees, a Canadian steamer, was reported fast on the rocky Alaskan coast and on March 29th the City of Topeka of the Pacific Coast Steamship Company went fast on a ledge in Wrangel Narrows.

As the engineer was not able to take the survey and improvement of the sea highway out of the hands of the government he turned his attention to terminals for the carriers both by land and water which

his skill had evolved, and here also the transition from the perfectly safe landing of the Indian canoe on the flat beach above high water to the equally safe landing of the ocean steamer at a deep sea wharf, beyond the fall of the lowest tide, has been through intermediate steps expensive and dangerous.

The first load of gold seekers in August, 1897, found no wharves at Dyea or Skagway, and the hastily gathered mining outfits were either lightered ashore at great expense, or at low tide dumped off the steamers to be submerged by the returning waters unless rapidly

LOOKING DOWN THE YUKON BELOW DAWSON.

moved by wagons whose owners charged extortionate rates. Prices for packing over the pass had been twelve to fifteen cents a pound in the old days of Indian-back, but they rapidly rose to forty-seven cents by the Dyea or Chilkoot trail and to sixty cents by the Skagway trail. Blockades occurred, paths turned into bottomless pits and pandemonium was everywhere.

It is a curious illustration of the fallibility of intelligent human judgment that nearly all the capitalists organized transportation companies to reach the Klondike by way of the mouth of the Yukon, leaving the nearer and obvious road in the hands of men without capital but with plenty of energy and ready quickness.

A comparison of the two routes to Dawson, down and up the river, should have been sufficient to convince one as to their relative values. Dawson is sixteen hundred miles from the Sound Cities. Of this distance one thousand miles are by inland sea, forty are by mountain pass, the balance down lakes and rivers. This route is open eight months in the year. By the other route it is over four thousand miles to Dawson, twenty-seven hundred miles of North Pacific Ocean to St. Michaels, and about fifteen hundred miles of treacherous river touching the Arctic circle with bars at mouth and elsewhere. Boats are limited to a three foot draft, and the river mouth is open but three months in the year.

The extent of the transportation delusion is evidenced by the increase of steamboats on the lower Yukon from scarce a dozen in 1897 to one hundred and ten by the summer of 1898. These boats represented capital. The gold seekers went the other way and the only real rivalry that there has ever been for a permanent Yukon route is between Dyea and Skagway, between the Chilkoot and White Passes. When the rush began, one of these was an Indian path, the other nothing, but, what it lacked in merit Skagway made up in boisterous advertising. The Indian village at Dyea developed into a town, the

THE MUD FLATS AT SKAGWAY.

(The railway runs along under the bank beyond the left wharf.)

THE WHITE HORSE RAPIDS.

American speculation on the Skagway flats was platted and the City of Skagway started. It first succeeded in building a wharf to deep water and this was the beginning of its supremacy, because it became easier and safer to land there. Beyond the landing this trail was utterly unfit for travel, but the first arrivals were too busy pushing on to warn those who might follow, and both town boomers and steamer lines assured ticket buyers that whatever might have been true last week, *now* the trail was indeed open.

Above its delta, the Skagway River, a mountain torrent, occupies nearly the whole width of the valley. The mountains rise steeply on each side and every spot that is not washed bare of earth is overgrown with heavy timber. If, in rare places the river has a shore, it is covered with boulders and loose rock, either terminal or lateral moraines of the former Skagway glacier, or the result of landslides. For ten miles from the sea, the fall of the Skagway River is not rapid but above the last fork, the stream rushing down from the summit of the White Pass is a rocky torrent, in a deep cañon bed. The rise in the last four miles below the divide is about 2,000 feet.

Illustrations, better than description, show the characteristics of the route from Lynn Canal to the white summit.

Over twelve thousand people landed at Skagway in the first year

after the rush, or between August, 1897 and July, 1898. Most of these unfortunates crossed the pass dozens of times carrying their goods in relays, a man load at a time, a slow way of transporting a ton or two of supplies a distance of thirty miles over almost impassable trails. Most of the packing was done on man back and extraordinary loads were carried.

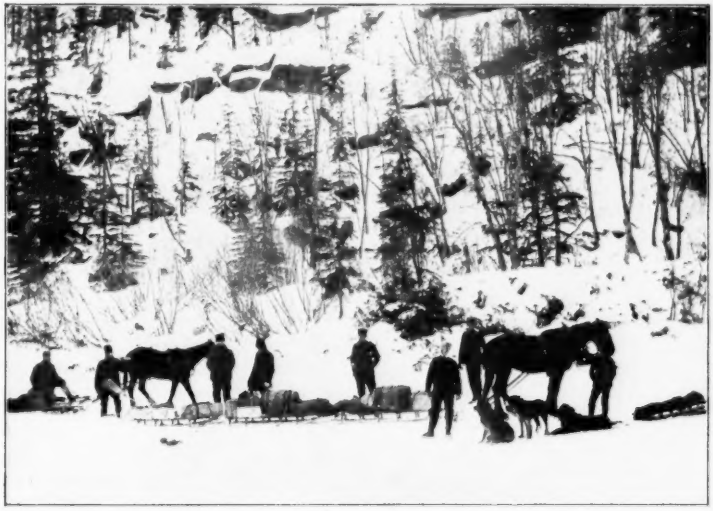
One of the Indians on Chilkoot carried in one load 247 pounds over the summit, and on the whole, nothing is so generally efficient as a man. Dogs were fitted with pack saddles and given loads of ten to thirty pounds, and this was worth while, at sixty cents a pound. Goats were used, rafts, canoes, rough boats, any and everything that could be impressed into service.

Horses were shipped to Skagway by the hundred, and there, on the worst trail in the world, they died also by hundreds, but during this first summer a horse was not able to carry as much as a man.

It was the packers, the owners of the horse trains who made the first trail, for the gold seekers had no time to join in any "good road movement," but the packers organized, instituted compulsory service and by the spring of 1898 had succeeded in opening a very fair bridle path, making this trail from this time on essentially a horse trail, and thus scoring a second triumph over Dyea. The horses between Skagway and Bennett each carried 250 pounds besides feed for the round trip of four days. Six to seven horses or mules made a string under the care of one man, the driver riding on an extra animal, sometimes in front, often behind. Rates for packing fell to twenty and then to twelve cents a pound and fortunes were made, and squandered, in the business. Six horses carry fifteen hundred pounds of net freight and earn gross $180 to $300. Expenses for a round trip were $40 in wages, $12 hotel bills, $25 for horse feed, $20 wear and tear and $15 toll, making a total of $112. Some packers who had forty to fifty horses on the trail put in their own boarding camps, thus reducing expenses and the most energetic and successful and reliable earned for several months over $1,000 a day net on an investment of $2,000 to $3,000. One energetic man interviewed the arriving Klondikers at Seattle, contracted to deliver their freight at Bennett, required a part payment in cash, used the cash to buy his horses and pack-saddles and went north on the same steamer with his customers and fulfilled his contract.

But the enormous amount of freight going to Dawson by way of the passes, nearly 20,000 tons, prompted Mr. George M. Brackett, an experienced and energetic railroad contractor, to begin a wagon road

from Skagway to the summit. He started early in the fall of 1897 and pushed the work with great energy, hoping to be ready for the great spring rush, but in this he was disappointed. The remoteness of the region, with mails ten days apart, labor, climatic and financial difficulties all combined to prevent rapid work. Nevertheless Mr. Brackett succeeded in building an excellent road for about ten miles, marring it however, and from an engineering point of view ruining it, by the fearful grade over Porcupine Hill, a grade so steep that two horses with a single sled loaded with only 400 pounds could scarcely climb it coming towards Skagway. Going down this same hill sled



HORSE TEAM FROM SKAGWAY TO LAKE BENNETT.
(One horse could make the round trip in three days, carrying 1,000 pounds.

runners are generally wrapped with heavy chains, in addition to the very effective automatic brakes used on all Skagway sleds. This brake consists of two sharp steel prongs bolted underneath the back end of the shafts and pointing downwards. When the horse pulls these are lifted off the ground or snow, but when on a down grade, the sled runs forward on to the shafts and presses the prongs deep into the ice or snow. Another effective form of brake is a dragging hook, bolted loosely through the back end of the runners. Ordinarily it is turned up and rests on top of the runner, but on down grades it is turned down so that the sharp end of the hook sticks into the runners'

AT WORK ON ROAD, 6 MILES FROM SKAGWAY.

track. On this hook the driver will stand, and thus hold almost any load.

On January 20th, 1899, a four horse double bob sled, not being equipped with these brakes, rushed the teams down the steep grade of Porcupine Hill and forced the leaders over the precipice, several hundred feet to the river below.

Mr. Brackett had built his wagon road without authority and there was indeed no time to wait for it, as the United States Government is always several years behind requirements in frontier matters. Very great friction developed between the wagon road company and the packers. The latter drove their pack horses up the frozen bed of the river and thus avoided the new road, but Brackett completed a short piece of road around which it was impossible to go and there he erected his first toll gate. While the struggle was going on in Alaska Brackett was not idle in Washington and secured the passage of a resolution by Congress giving the Secretary of the Interior jurisdiction over Alaskan roads with authority to grant toll privileges. From the Secretary of the Interior Brackett obtained authority to levy a toll of two cents a pound on all freight, ten dollars on each wagon, one dollar on each foot passenger, horse, sheep, dog or other animal. These rates were excessive. This wagon road owing to its heavy

grades was none of the best. In building it Mr. Brackett had in many places simply improved the previously existing trail made by the packers themselves. The road was only built for eleven miles, yet without proper investigation, without any comprehension of the actual conditions or of the equities, the privilege was granted to levy prohibitive tolls on all the enormous traffic using this pass. There was not even any possibility of appeal, as no court had any jurisdiction over tolls placed by act of Congress at the discretion of the Secretary of the Interior.

The wagon road however experienced difficulties. The Chilkoot Pass route had not been idle, and from the first as a man pack route it had been preferred to the White Pass because shorter, with better approaches and with more direct water ways to the head of Yukon navigation.

The first improvement on this pass was made when a horse whim was anchored at the summit of Chilkoot, and by this means loads of over a ton could be hauled up on sleds, thus putting this route far ahead of the Skagway trail for heavy freight as well as for single loads. After the first season the horse gave way to a gasoline engine, his last act being to wind his own sucessor to the top. The gold seekers could drag their own loads on sleds to the foot of the summit,

WAGON ROAD THROUGH THE CUT-OFF.
(Showing the road 3½ miles from the summit of White Pass.)

CUTTING ROCK FOR GRADE ON TUNNEL MOUNTAIN. FISK'S CUT.

there turn them over to the whim, be hauled up, coast down the other side and go on their way rejoicing over the frozen lakes and smooth trail to Bennett..

As early as August, 1897, work was started on the Chilkoot Railroad and Transportation Company, on the Alaska Railroad and Transportation Company and on the Dyea Klondike Transportation Company, all three of them aerial cable trams. These three were ultimately consolidated into the Chilkoot Pass Route and but one line

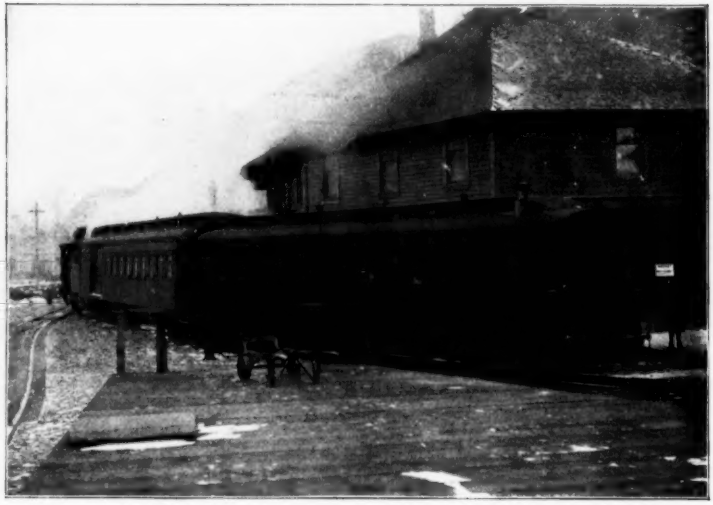
TUNNEL ON THE WHITE PASS AND YUKON ROUTE.

finished in April, 1898. A large force of men was kept busy all winter, but very little beyond shovelling snow was accomplished from December 10th, 1897, to March 15th, 1898.

Two illustrations show transportation over the Chilkoot, one a March scene, men packing, the whim dragging a heavily loaded sled, the wires overhead; the other a midsummer scene, with a Peterboro canoe swung in mid air. This tram begins nine miles from Dyea at

Cañon City, to which place a wagon road is almost without grade. There are two loops, one from Cañon City to Sheep Camp, four miles, and the other from Sheep Camp over the summit and one quarter mile down the other side. This loop is four and one-quarter miles long. The trolley automatically switches from one loop to the other, and the load is limited to four hundred pounds, generally carried in boxes 40 x 20 x 24 inches.

With its level wagon road and these trams in operation the Dyea trail should and could have beaten its rival Skagway as to rates, but it could not handle the freight offered, and there were long delays,



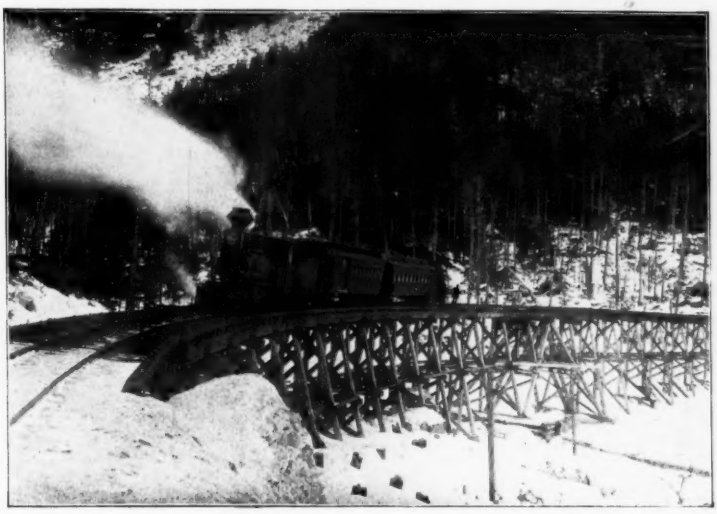
PASSENGER TRAIN LEAVING SKAGWAY FOR THE SUMMIT, FEBRUARY 20, 1899.

charges of favoritism, and enough freight was secured at the Skagway rates of eight cents and up to keep the trams busy, so no reduction was made.

It was nevertheless this Dyea competition which forced a reduction of tolls on the Brackett road from Skagway, the rate being lowered to one cent a pound from Skagway to summit and three-quarters of a cent a pound to those who made their way up the river bed. Some packers also threatened to build a new trail of their own, and one energetic man with over one hundred tons of freight to carry was bribed from so doing by a free pass for his stuff.

All these transportation, financial and competitive struggles were

around and about the passes, the stretch from salt water to lakes. From the head of Lake Bennett down to Dawson, "over the ice" as it is called, the travel in winter is only by dog team, although this year one mule and one horse made the trip out. The Yukon sleds are sixteen inches wide, six feet long, eight inches high and strongly braced. Some are made with a gee pole on the right side, and the driver straddles the rope or chain by which the dogs pull. The preferred sled this year is the basket pattern with plow handles behind to which the driver clings. Four to eight dogs make a team. On a good



FIRST PASSENGER TRAIN OVER WHITE PASS AND YUKON ROUTE.

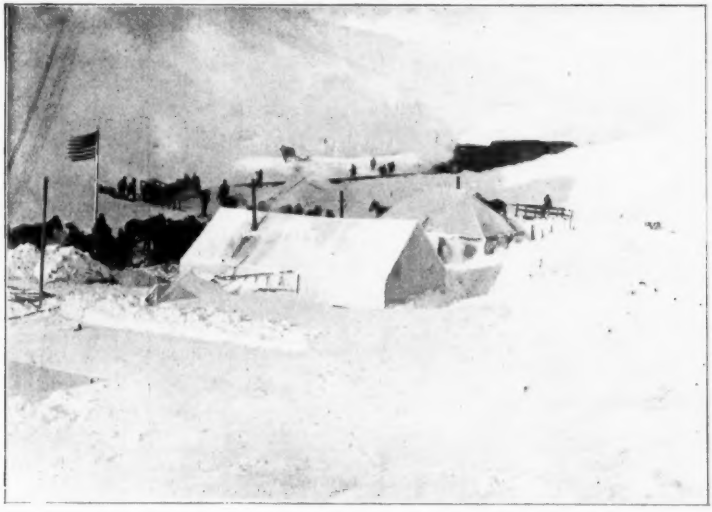
(Crossing east fork of Skagway River, February 20, 1899.)

smooth trail the native dogs, "insiders" as they are called, one-quarter, half or even three-quarters wolf, will drag one hundred pounds to the dog. These animals are thickly furred and seem to enjoy extreme cold. They are fed on boiled rice, corn meal and bacon, and will not eat dog biscuit. Outside dogs cannot stand the extreme cold, are not as a rule as good pullers and are miserably unhappy. At Skagway good insiders are worth from fifty to one hundred dollars; outside dogs can be bought for ten to twenty dollars. Up the White Pass and through fresh snow dogs cannot pull fifteen pounds. The extreme difficulties of the White Pass make a dog team trip from Dawson to

FIRST PASSENGER TRAIN ON THE WHITE PASS AND YUKON ROUTE TO THE SUMMIT, FEBRUARY 20, 1899.

Skagway much easier than from Skagway to Dawson, as the dogs are not worn out before they are fairly started.

The rapidity of travel with a good dog team is remarkable. Mr. Thomas Crahan left Dawson City January 28, 1899, at 9:45 o'clock, A. M., and reached Skagway February 12th at 4:45 P. M. He had two in his party and a four dog team to haul the equipments. While on the trail he fed his dogs once in the twenty-four hours, at night, each dog receiving two and a half pounds of food, which consisted of one and a half pounds of thoroughly boiled bacon, three-quarter pound



ARRIVAL OF FIRST PASSENGER TRAIN AT SUMMIT OF WHITE PASS.
(White Pass and Yukon Route, February 20, 1899.)

of well cooked rice and one quarter pound of cooked corn meal. The distance is full six hundred miles but although the dogs averaged more than forty miles a day they were in good condition.

On January 29th I turned over to M. A. Mahoney at Tagish 2,000 pounds of American and Canadian mails. He had four sleds with five fine dogs to each sled, and on each sled he loaded 500 pounds of mail or 100 pounds to each dog. He reached Dawson on February 26th. Returning he left Dawson March 21st at 9 o'clock A. M. with one passenger, the contract being to land him in Skagway in fourteen days, for $700 or to forfeit $100 for every day over that time. He

pulled into Skagway on the afternoon of March 31st at 5 o'clock, having made the trip in ten days and eight hours, or at the rate of fifty-five miles a day. The team consisted of six huskies (Arctic dogs), and he carried no supplies with him, buying everything for himself and dogs at the bunk houses along the river.

If a dog team has to carry its own food and that of the driver and thirty to forty pounds of blankets, robes and other equipments its radius of travel is very limited. Mahoney's teams could barely have

PASSENGER TRAIN COMING DOWN FROM SUMMIT.
(White Pass and Yukon Route, February 20, 1899.)

reached Dawson carrying their own supplies and no extra freight whatever. It is because there is no food for horses along the trail that these animals or mules are not used. A good horse can drag about two thousand pounds over a fair trail on a food allowance of forty pounds a day. He can travel through fresh snow that would stall any dog team, but the latter can travel over crusted snow that would break under horses. Wherever the food supply permits freighting is done with horses and mule teams, as between Skagway and Tagish one hundred miles towards Dawson, but for light and rapid

DOG TEAM WITH "OUTSIDE" DOGS.

running from place to place dogs are preferred. Each dog is as much trouble to care for and more trouble to feed than a horse.

During the summer of 1898 pack trains were in full action over the White Pass and the trams over the Chilkoot, and the healthy rivalry between them prevented too great extortion. About this stage of development civilized modes of transportation may be said to have overtaken in convenience and cheapness the primitive savage methods. It was just about as cheap to send goods over in July, 1898 as in July,

DOG TEAM WITH "INSIDE" DOGS.

1897, before the rush had begun, but a new competitor now appeared in the field that was for all time to settle the supremacy of Skagway. This new comer was an international railroad, whose survey ran twenty miles through American territory from tide water at Skagway to the summit of the pass and the international boundary, and thence three hundred and twenty-five miles to Fort Selkirk, on the Yukon River, below White Horse Rapids and other dangers and but one hundred and seventy-four miles above Dawson.

This railroad is now in operation to the summit of the White Pass and much of the grading is done for twenty miles more to Lake Bennett. If it should stop here the aerial tram could still prove a dangerous rival, because the capital charges are so much less, operating expenses less, and its capacity could be easily increased to one hundred tons a day. The difficulty has been, not in transporting but in handling the freight at the two termini, where accumulations almost inextricable confusion and long delays.

Freight rates from Dyea to Bennett by way of the tram are, in March, 1899, three cents and a half a pound, and the same by the railroad. From the summit the railroad company has opened one of the best snow roads in the world. It was made by sending team after team through the snow drifts, packing down the snow until the hard bed rose above the level of the snow field and was thus swept clear by the wind. It is staked with saplings on both sides and can be followed in the darkest night or severest storm. Log Cabin, the custom house and mounted police station, is twelve miles from the summit and boundary, and is also at the end of the White Pass series of lakes, Summit, Middle and Shallow. The former trail from Log Cabin to Bennett was difficult both winter and summer, as it passed over a high and rocky divide, winding steeply up and down along the slopes. The new railroad trail was opened by cutting down trees, grubbing out stumps, blasting away boulders, packing down snow drifts, and is a beautiful and model road.

Freight carried to the summit by the railroad is there transferred to double bob four-horse sleds with wide runners and each such sled can be loaded with half a ton. Three or four of the freighting firms have formed a through freight line in connection with the railroad and through bills of lading are issued. A big freighters' camp is established near Log Cabin half way between the summit and Bennett and each morning except Sunday (for the mounted police will not allow freighting on Sunday), teams start in both directions, thus giving the horses ten miles of load down grade, and ten miles empty.

The railroad hauls to the summit of the pass for one cent a pound or one-half of the toll authorized by Secretary Bliss for the privilege of dragging one's own freight over the toll road. The freighters carry for two cents a pound from the summit to Bennett. The expenses of the round trip are about $20; receipts under best conditions, which are the exception, may amount to $200. If there were a sufficient quantity of freight there would be a bonanza in the business for a freighter with ten or more four-horse teams. As it is, the freighters alternate between excessive earnings and inability to pay their teamsters or other bills, none of them being organizations with large capital. The snow trail is not in good condition until February and begins to soften the latter part of April. The lakes are deep and well warmed during the long summer days, but in early winter the first sharp frost covers them with a thin crust of ice. On this a blanket of snow falls, which delays further freezing and presses the thin ice below the water, so that beneath the snow there is oftentimes slush two or three feet deep. Horses and men break through the upper snow, and the resulting wetting is dangerous with the thermometer 20° or more more below zero and the wind blowing.

The railroad is a great example of engineering and constructive skill. It would have been a great feat to grade forty miles and build twenty over a similar rocky pass under the most favorable conditions, but this work was done in seven months, in a region without laborers, one thousand miles from supplies, three to four thousand miles from rolling mills and car shops, and against fearful climatic conditions. Day after day fresh snow drifted over the road bed and day after day it had to be shovelled off, sometimes to a depth of six to eight feet. Supplies, bridge timbers, fire wood even, for the enormous camps had to be carried over almost impassable snow trails. There were days when men could not work on account of the storms or the intense cold, but they had to be fed and warmed.

The road begins on deep water, a mile from Skagway. A shelf is blasted along the face of the cliff, and this beginning is typical of the twenty miles to the summit. High above the valley, on a maximum grade almost the whole distance, the road sweeps around two different forks of the Skagway river, adding six miles to its length but making it possible to reach the summit of 2,885 feet without switch back. It has however been questioned by able engineers whether this was the best location. The strata dip from east to west, and the other side of the valley would give a stable instead of unstable ledge. The west side is also the sunny and protected side, freer from ice and snow,

but on this side a switch back could not have been avoided. The road is narrow gauge, but the road bed and construction are adapted for broad gauge. It is one of the most solid and substantial road beds in America. The illustrations show the character of the work.

This railroad has already made Skagway the coming city of Alaska, and thus ended the race between the older Indian Dyea and the younger American city. It will do more. It will change the freight route to Dawson from an up-river to a down-river movement. Even this year barges to carry twenty tons can be bought at Bennett for $300. or, competent men will contract to deliver freight with their own barges for four cents a pound to Dawson. Contracts are now being made from Seattle and Tacoma, from Victoria and Vancouver to Dawson via the White Pass for $160 a ton, or eight cents a pound. This through rate may fall to six cents when the railroad reaches Bennett. Even eight cents is lower than the rates hitherto charged by the long mouth-of-the-Yukon route. Passenger travel will all take the shorter road and freight will inevitably follow passengers.

Another and more serious result of the completion of this railroad line to the summit is the inevitable diversion of a trade thus far almost exclusively in American hands to Canadian points and houses. Last year, the high duties imposed by the Canadians were fully off-set by the extortionate charges made for bonding and convoying Canadian goods through the American strip. This year the railroad furnishes the bond for a nominal charge and ships Canadian goods in bonded cars, delivering either at summit of pass, in British territory, or at Log Cabin or Bennett. It is not possible for American merchants to stand thirty per cent. duty and also the Canadian custom house delays, annoyances and extortions at Log Cabin. Last year Americans made these annoyances an off-set for a thirty per cent. duty, but hereafter the Canadians are protected by both duty and annoyances, and even if American meats and hardware are taken to the Yukon they will enter Canada elsewhere and go through in bond.

Happily however this possible loss of Klondike trade will be more than offset by the very sensational discoveries of gold made near the shores of Bering Sea, at Golovin Bay and Cape Nome. The climate at these points is comparatively mild, they are most easily accessible by boat for five months in the year and the region is described by those who know it as an Arctic paradise.

The Klondike madness is past. In two short years the savage trail with a dozen Indian packers has been replaced with transportation facilities with a capacity exceeding the requirements of the

Yukon basin for years to come. This excess will stimulate further developments. The country offers the widest field, for it is inexhaustibly rich.

Nowhere else as on this gold trail has the genius of engineers wrought such beneficient and rapid change in so short a time.

The evolution from hunter's path to railroad, through the intermediate steps of pilgrim path, mule trail, wagon road, was two thousand years in making in the Saint Gotthard Pass, the great high road between the most civilized portion of the ancient world and of the mediæval world, the road that led from the gloomy north to the rich south, rich in treasures, in food, in spiritual tradition and comfort.

Two short years as against two thousand have evolved the same succession of improvements on the highway over the White Pass back to a north, hideous in climate, without history, without sentiment, without food, but abounding in gold.

The author desires to acknowledge the permission given to him by Messrs. Winter & Pond, of Juneau, Alaska; Mr. E. A. Hegg, of Skagway, Alaska; by the White Pass and Yukon Route Railway and by the Chilkoot Pass Railway, for the use of the copyrighted photographs from which the illustrations have been made. None of these illustrations may be reproduced without the permission of the owners of the copyrights.

THE UTILISATION OF THE WATER POWERS OF ITALY.

By Enrico Bignami.

WHILE on the one hand Italy is extremely rich in water powers which are capable of utilisation, on the other hand it is absolutely destitute of coal.

The Alps close it in from the northwest to the northeast, from the pass of Cadibona to Mount Majore, and slope to the sea level with steep and short gradients. The Appenines stretch from one end of the country to the other along its axis, from northwest to southeast. By these mountain chains the country is divided into three water sheds: the eastern, or that of the Adriatic Sea; the western, or that of the Tyrrhenian Sea; the southern, or that of the Ionian Sea.

The water-shed that drains into the Adriatic can be subdivided, according to mountain ranges and principal rivers, into the watersheds of the upper Adriatic (which includes the great basin of the Po), the secondary basins between the Po and Marecchia, the Venetian basin, the coast of Trieste, and the peninsula of Istria. The rivers of this water-shed are:

(I.) The Po, with the following tributaries on the south: The Tanaro, Trebbia, Taro, Parma, Secchia, Panaro, Reno, etc.; and those on the north: the two Dores, the Stura di Lanzo, Sesto Agogna, Ticino, Adda Oglio, Mincio, etc.

(II.) The Adige.

(III.) The Brenta, Sile, Piave, Tagliamento, Isonzo.

A very few and unimportant torrents, namely, the Quieto, the Leme and the Arsa, empty into the upper Adriatic from the Istrian peninsula.

The other rivers of the Adriatic watershed are, from the north and south: the Foglia, Metauro, Esino, Potenza, Chienti, Tronto, Pescara, Sangro, Trigno, Biferno, Fortore, Candelaro, Cervaro, Carapella, Ofanto.

From the Tyrrhenian watershed, starting from the north, the torrents are: the Roja, Impero, Letimbro, Polcevera, Bisagno, Entella, and the rivers: the Serchio, Arno, Cecina, Cornia, Omborne, Tevers, with their numerous tributaries, the Garigliano, Volturno, Sele, Liri.

The Ionian watershed is less important. It shows such little rivers as the Crati, Basento, Bradano, etc.

The longest rivers, and those draining the greatest area, run through the largest if not the most fertile stretches of agricultural lands, these also being the most industrious and enterprising regions of Italy. For example, Piedmont, Lombardy, Liguria, Emilia occupy the broad basin of the Po, and the greatest part of Venetia lies in the basin of the Adige. For centuries the principal wealth of these regions has been their industries, namely, silk, textiles, agriculture, cheese making, etc., but while the more recent industries are not lacking, yet they are pursued only in a very insignificant manner. Italy is thus under tribute to the rest of Europe for many articles which she might just as well produce at home if modern methods of production and power-supply were introduced.

As an example of the difficulties encountered we may take the case of calcium carbide. Although this valuable material was discovered as early as 1888, nothing was done to manufacture it in Italy until 1897. A few attempts were made in 1896, but nothing of consequence was done, and during that year 797 quintals (of 100 kilogrammes each) of Swiss carbide were imported into Italy. A furnace of fifty kw. capacity was started at Pont St. Martin, near Evrea, in 1897, but on account of disagreement among capitalists the enterprise closed down at the end of two months, and the right to take 2,000 h. p. from the stream, the Dora Baltea, was forfeited.

Other attempts have been made, however, among which we may mention the *Societa Italiana dei Forni Elettrici,* with a capital of 100,000 lire, operating under the patents of Engineer Lori, and starting its works at Narni in March of the same year. This was followed by the *Societa Italiana pel Carburo di Calcio,* with a capital of 3,000,000 lire, and operating under the patents of the Aluminum Gesellschaft of Neuhausen, with a manufactory near the falls of Terni. About the middle of 1898 the *Societa Italiana dei Forni Elettrici* remodeled an old building near the gate of Foligno, and converted it into a carbide works, a power of 1,000 h. p. being transmitted seven kilometres from a waterfall 160 metres high on the Menotre. A power station was also constructed at the close of 1897 at St. Marcelle, near Aosta, where 700 h. p. were generated, and at Poggio Mirteto a small carbide works was constructed by Mongini, equipped with an improved electric furnace, built by Siemens & Halske, provided with movable bottom, tubular electrodes and a regenerating attachment for use with water gas. In addition to these the *Societa Anonyma Veneziana di Elettrochimica* was chartered in 1898, with a capital of 600,000 lire, but its factories are abroad,

the first being at Paternino, in Carinthia, where two Lori furnaces are being constructed.

These few examples show what may be done, and in fact there is no country in the world which, by reason of its mountainous slopes, its needs, its absolute lack of coal and its scarcity of other fuels, which can be expected to profit more than Italy by the development of electric power stations for the utilisation of the immense potential energy of its rivers and streams. If Italy had earlier attempted to substitute power derived from her own waterfalls for that imperfectly and expensively supplied by foreign coals, her present manufacturing and commercial inferiority would not be so humiliating. Possessing as she does valuable deposits of iron ore and copper, yet nearly all of this is exported, while the manufactured articles are imported, some of them from the very countries which purchase the raw material from Italy. If therefore electro-metallurgical processes could be substituted for the older methods the current required could be developed from the numerous water powers. At present the metallic imports of Italy come from America, Sweden and England, but with a home article in the market, produced by Italian water power and with cheap Italian labor, the double freight charges on exported raw material and re-imported products would form a natural protective tariff for the home product.

One of the principal difficulties in connection with the development of Italian industries lies in the fact that Italian capital has always shown itself reluctant to embark in industries of recent development, so that it has come about that German houses have taken the commercial lead, remodeling and expanding certain industries, and starting new ones. A most promising future might be realised for Italy if individual efforts could be backed by strong Italian financial concerns, who would map out a complete and comprehensive programme, using the water powers of Italy for agriculture, for industry and commerce, reclaiming marsh lands, improving existing industries and creating new ones, making more products for interchange, and ultimately increasing exports.

The question of drainage alone is one of utmost importance to Italy, and one which the development of water power could be used to solve. Out of the 259 districts into which Italy is subdivided only sixty-five are free from malaria, while nearly all could be relieved from this disability by proper drainage, and where necessary the drinking water could be sterilized by ozone, for all of which work the power is readily available, if capital were only forthcoming for its development.

Various laws, particularly that of August 10th, 1884, define the formalities which have to be complied with, and the conditions under which individuals or chartered companies are permitted to appropriate the power of public streams. The laws require that the applicant shall specify the business in which he intends to engage and the use he intends to make of the water, so that the government officials may consider the worthiness of the request, and, in case of doubt, refuse it. If the request has been granted and the applicant pays regularly the treasury dues or tax at the rate of 3 lire for each horse power granted, he becomes absolute owner of the right for thirty years; but he is under no obligation to develop his grant if he does not so wish. At the end of thirty years, if he has made use of it as promised, he acquires a perpetual right of renewal, in periods of thirty years each; otherwise he forfeits all rights. This provision is a wise one, as any water power not properly developed lapses again to the state.

Grants are allowed by the prefectures in which the power is situated, the exceptions being certain streams of special importance owing to their geographical position, such as those near the boundaries. The right to make grants on these is reserved by the general government.

In case of conflicting grants the present law recognizes only priority of application and grant. The same law provided that all the streams of the kingdom should be surveyed, but no appropriations were made for this important and costly work, and this feature has practically become a dead letter. The hydraulic officers of the Ministry of Agriculture and Commerce have only completed hydrographic surveys of the following rivers: the Tiber, the Arno, the Liri, the Garigliano, the Volturno and seven smaller ones.

The inconveniences and imperfections of this law, scarcely noticeable when the attempt to realise the water powers were of such a primitive character, became daily more apparent, as with the increase in the number of applications it was found that a priority right of a few horse power could check the utilisation of the greatest powers, thus causing serious harm to the country, which had been counting so hopefully on the increase of electrically-driven factories. Therefore, towards the end of 1894 a Ministerial Committee was appointed, whose business it was to propose needed amendments. This committee performed its work, but notwithstanding the excellence of the recommendations no legislative action was taken, and the old law remained unchanged.

In 1898 the matter came up again, for both the government and

the railroad companies had undertaken many investigations looking towards the use on a grand scale of electric traction on the railways.

The moment success had been obtained in the development of electric traction in other countries it was only logical that in a country poor in coal and rich in water power the idea should be broached of using the natural power of the country for its home needs. We do not propose here to discuss the question whether this is the best use that can be made of the water power, or whether it can altogether replace steam locomotives. Each particular case must be investigated in detail by competent experts; but it appears certain that in many cases these powers can be profitably used. The probability of the water powers acquiring value for this purpose has stimulated private applications for the very best of them, so that the government became alarmed, and under the seal of the Minister Afan de Rivera issued a circular conceived with the best of motives, but most unfortunate both in the regulations prescribed and in its consequences.

Among other provisions this circular ordered, that before a concession or grant were made it should be ascertained whether in any manner, direct or indirect, the water power in question might have any value for the railroads or for the state manufactories. If such were the case the application must be referred to the Central Administration. Most serious and illegal were these orders, for, thus by means of a simple ministerial circular, the spirit of a law passed by parliament, and still in force, was set at naught.

This Draconian act of the ministry interfered with too many private interests, and when its import became generally known protests were made on all hands. Some parties found themselves suddenly blocked in obtaining a grant long expected and applied for, applications were rejected that had cost them considerable sums of money and much expenditure of time, and on which they counted to extend establishments already in operation or to begin new ones, and their protests were more than just. Then there were also the mere grabbers, who added their protests to the others, claiming that their rights or expectations under the existing law had been infringed.

The circular of Afan de Rivera had to be withdrawn, but nevertheless the present law will soon be modified, and the commission appointed *ad hoc* has already formulated its proposals, which deserve to be reported at length, because the new law shortly to be approved with very few modifications will follow them without change. They are as follows:

(1) Instead of mere geographical subdivisions of the water system,

that of relative importance has been substituted. Local authorities make the grants for all powers of less than 200 h. p., all others being reserved by the central government.

(2) The terms of any grant must be complied with before a predetermined time, or it will revert to the state.

(3) Grants already made can be merged into larger grants, provided those thus expropriated are indemnified by an equivalent quantity of water or of electric energy.

(4) In ascertained and imperative cases of necessity to the state it can reserve for its own use a water-power applied for by an individual, nor is it necessary for the state to have the same recourse to condemnation proceedings as would be necessary in the case of an individual.

A permanent Ministerial Commission is to be appointed to pass on all the applications which may affect the needs of the state.

(5) In case of rival claims priority has the right of preference if both cannot be granted, but that claim is to be favored which seems to promote the greatest public utility.

The provisions of the proposed law will certainly result in protecting both the state and real industries against mere grabbers. But in our opinion two amendments should be added if certain secondary but, on that account, not less valuable advantages are to be secured.

(a) The interests of the state are not narrowly those of the administration but in the largest sense those of the whole country. For example, the increase of some tax may benefit the treasury by adding to the revenues, but the increase does not on that account add to the real prosperity of the country. Thus also the impounding of water to furnish power to some military barracks, or even to drive a railroad, may, it is true, save the state some money, but this does not mean that the country as a whole is as much benefited by this public use of water powers as it would have been if private parties or companies had used it to establish a new industry.

(b) Oftentimes the survey and scientific study of the conditions affecting some water power require long and expensive preliminary outlay, and such investigations are similar to those required in exploring for metals and other minerals, and they should be afforded the same protection.

The distant transmission of electric energy is subject to the law of June 7th, 1894, of which the following are the most important provisions:

Article 1.—Every landowner must grant right of way through his

possessions for electric wires, either suspended or underground, to those who have secured the right, either temporary or permanent, to use electricity for industrial purposes. Exempt are the fronts of houses towards the public streets or squares, courts, gardens, fruit arbors and garden patches adjacent to the dwelling house.

Article 3.—Right of way must always be given to the transmission wires over canals or aqueducts or other erections, provided this right of way does not impede or diminish their usefulness to their owner.

Article 8.—The owner of electrical conduits is under obligation at all times to obey all laws and regulations made concerning materials, or that are, or may be passed to govern communications by means of the telegraph or telephone.

Rules:

Article 5.—The wires or conductors of an electric plant crossing public streets, railroads, rivers, torrents, canals, telegraphic or telephonic lines of public service, or erected near these, or that pass near or are attached to public monuments, cannot be erected without the previous consent of competent authority, unless the work has already received official approval as a work of public utility. All other conductors may be strung without official approval, but must be announced to such authorities at least ten days before work is begun.

Article 10.—In both the stringing of wires and the use of electric conduits the owner will be held responsible for public safety, and he will be required to use every precaution approved by science or practice, and especially to observe usual precautions.

Article 12.—It is particularly forbidden to string electric wires along streets or roads or the banks of streams, torrents, or canals already used or to be used for public telegraph or telephone service. Any exception must first be authorized by the Minister of Posts and Telegraphs, who will make it his business to determine the cases in which two different circuits can coexist without damage to each other, or what safeguards will be least burdensome.

The *Associazone Elettrotecnica Italiana* has appointed a commission and charged it to formulate laws suitable to the electric needs of Italy, recommending it to make use of all the information to be derived from similar German, Swiss and French societies.

In the mean time plants are multiplying, and already central staions are to be counted by hundreds and private plants by thousands. Most of these have been fitted up with foreign supplies, the house of Brown, Boveri & Co., of Baden, being at the head, as it has supplied many machines, mostly for alternating current, with nearly 30,000 h. p.

in the generators and about 12,000 h. p. in the motors. One of these machines is the generator of 1,500 h. p., furnished for the large plant in Paderno, where a water power of about 20,000 h. p. along the Adda is to be converted into electricity, to be used in Milan for public and private lighting and for traction.

This is the largest hydro-electric plant either already completed or about to be undertaken. Calculations were based on a fall of 28.81 meters carrying 45 cubic meters of water at its lowest stage, and a fall of 24.86 with 52 cubic meters at flood, yielding a total of 17,300 theoretical h. p. Six units of 2,160 h. p. each are to run regularly; the seventh is in reserve. The turbine in double, with axial discharge and centripetal entrance, and each wheel uses 7,809 liters a second when running at a speed of 180 revolutions. The fall is divided into 22.87 meters pressure and respectively 5.94 and 1.99 draft for low water stage and flood.

The current is three-phase alternating, the tension 13,500 volts, and a frequency of 42 cycles per second. The estimated loss is 9 per cent. in energy and 16 per cent. in tension; the distance is 34 kilometers in almost a straight line.

Next to the house of Brown, Boveri & Co. comes the firm of Ganz & Co., of Budapest, which generally furnishes both electric furnaces and turbine wheels of its own make, followed by the houses of Shuckert & Co., of Nuremberg; the establishment of Oerlikon, near Zurich; Siemens & Halske, of Berlin; Alioth & Co., of Bale; the Compagnie de l'Industrie Electrique, of Geneva.

The strongest Italian house is the Technomasio, of Milan, after which come Gadda & Co., and Brioschi and Finzi, who make a specialty of alternating generators and motors. There are other firms in Turin, Genoa, Savigliano, in all about ten, who cannot begin to suffice for the needs of the country, especially since the idea of utilising public waters for private plants of every kind has become so popular.

Recent official statistics give the total horse power of the steam boilers of Italy as 160,000 h. p., not including those for lighting plants, for traction of tramway lines and railways, nor marine boilers of any kind. Compared with the statistics of other countries Italy, to occupy a similar rank, should have at least 2,000,000 h. p. in order to compete industrially. In addition to the 300,000 h. p. already taken up, it has been calculated that about 5,000,000 h. p. remain, if proper use is made of the rapid falls of the Italian rivers, the Po alone being estimated to be capable of furnishing 1,000,000 h. p., at a cost for plant not exceeding 600 lire per h. p.

Data from a number of existing plants indicate that thus far the cost has averaged 300 lire per horse power, but even if they have cost double this amount they would pay well compared with steam. The operative cost of water power, including supervision and repairs may be put at 70 lire per h. p. per annum, operating 24 hours daily, while steam power costs at least 200 lire per h. p. per year of 300 days of 10 hours.

The advantage of water over steam is still more marked if it is taken in the mountains, near to the source of the hydraulic power and farther from coal. Here we may safely estimate the price of an electric horse power at 50 lire per year, while that of steam is at least 500 lire, an important feature when the use of electric power in metallurgical operations is considered.

YEAR.	INDUSTRIAL USE.	OTHER USES.	TOTAL.
1888	77	37	114
1889	85	31	116
1890	58	22	80
1891	55	24	79
1892	74	31	105
1893	67	30	97
1894	55	28	83
1895	26	56	82
1896	83	42	125
1897	87	37	124
Totals	667	338	1005

Grants of public waters from 1888 to 1897 in the various provinces:

PROVINCE.	MOTIVE POWER.	IRRIGATION.	TOTAL.	MODULES.
Piedmont	173	20	193	1986
Lombardy	93	15	108	2351
Venetia	77	34	111	617
Liguria	83	15	98	188
Emilia	38	14	54	275
Marches and Umbria	40	14	54	521
Tuscany	44	9	53	81
Latium	14	8	22	276
S Adriatic	57	26	83	285
S. Mediterranean	18	16	34	198
Sicily	29	22	51	21
Sardinia	5		5	12
Totals	671	193	864	6711

As already stated, the law of August 10th, 1884, reserved to the central government the right to grant public water powers arising from lakes and from border rivers, leaving all others under the jurisdiction of the prefects of the different provinces in which they are situated.

In one of the official bulletins, the list on page 786 gives the grants in the ten-year period from 1888 to 1897.

The following table shows the extent of ground for which irrigation grants were made from public streams in the ten years between 1888 and 1897, and also the motive power developed under similar conditions during the same period:

PROVINCE.	HECTARES.	HORSE-POWER.
P edmont	777	33,021
Lombardy	1,170	49,795
Venetia		4,971
Liguria	7,166	2,318
Emilia	959	
Marches and Umbria	558	14,076
Tuscany	327	559
Latium	558	12,245
S. Adriatic	10,504	1,340
S. Mediterranean	4,221	3,590
Sicily	905	395
Sardinia		7
Totals	33,779	122,317

A study of the grants made in each year shows no real uniformity in the apportionment of public streams to agriculture and to industrial use. In the first six years of the ten-year period irrigation rights granted covered 31,142 hectares, and the horse power amounted to only 40,194. For the whole period the hectares were 33,779 and the horse power 122,317. This shows that in the first part of the decade there was a greater demand for irrigation plants, and during the last four years a greater development of power for industrial purposes.

Under these circumstances it is pertinent to ask: Why should not the State encourage industrial projects upon which a moderate tax of 3 lire per h. p. per year would return an annual amount of 20,000,000 lire? This figure may seem large, but it must be remembered that Italy now spends annually abroad not less than 100,000,000 lire for coal alone, not to mention the amounts expended for petroleum and minerals and metals which might be obtained at home.

The feeliny is everywhere strong that the utilisation of water

power will soon be in full swing, and will bring with it the benefits coming from the development of home enterprises. That this will be accomplished with the aid of municipal undertakings is indicated by what has already occurred in Terni, Spoleto, Foligno, Narni, Spezia, Padua and elsewhere.

The law of December 27th, 1896, governs the chartering of electric car lines, but as yet the particular regulations have not been promulgated. This law does not even mention electric traction in Italy, but already there are electric lines in Rome, Turin, Genoa, Milan, Florence, Livorno, Naples, Varese and Bergamo, and they are being put in at Palermo, Catania, Messina, Spezia and elsewhere. Nearly all of these are equipped on the Thomson-Houston system, with overhead trolley.

But the new laws, which are now being prepared, will certainly provide for the regulation of electric traction, especially as experiments on a large scale in electric traction applied to standard railroads are being inaugurated by the two most important Italian railroad companies—that of the Mediterranean and of the Adriatic, in which the relative advantages of trolley, of third rail and of storage batteries are being compared. This last system is being tried and studied on a stretch of road with very frequent trains, between Milan and Monza, a distance of 13 kilometers. The experimental operation with third rail will be tried on a line 30 kilometers in length, while that with trolley will be on a third line 50 kilometers in length.

The *Associazione Elettrotecnica Italiana* has not yet decided which of the three systems is applicable to the solution of the traction problem on main-line railways, but has declared itself in favor of facilitating and accelerating the trials with the different systems, and has also recommended that the authorities should permit the use of high pressures on the main wires of primary lines, especially contact systems, proper and minute regulations being adopted to guarantee the public from danger and injury.

If electricity generated from water power is to be used for railway purposes it will necessarily involve transmissions over relatively great distances. If the equivalents of 500 to 1,000 h. p. are to be transmitted over distances of 50 to 100 kilometers pressures of 2,000 to 3,000 volts at least must be used. There is, however, no reason why such pressures should not be safely used, and both Kapp and Thompson maintain that there is no good reason why the common limit of 500 volts pressure should be considered, it being altogether probable that the usual limit of 500 to 600 volts will be abandoned in favor of

higher voltages for use on electric railways. Weber, of Zurich, very properly calls attention to the fact that the dangers from high pressures in electric railways are small compared to the other dangers inherent in any railway service. The possibility of disastrous accident when running trains at speeds of 60 to 70 kilometers an hour on dark and stormy nights is far greater than that involved in any form of electric driving.

The true solution of this portion of the problem appears to lie in the adoption of polyphase currents of high pressure directly in the motors. It is true that the polyphase current is deficient in that flexibility of speed regulation which is demanded in city tramway lines, but it appears to be well adapted for the special conditions and more limited requirements of main-line railway service. In this case various methods of regulation may be adopted, either by the insertion of artificial resistance in the induction or inductor circuits, or else there may be a double equipment of motors, one of which will be operated continuously at high pressure, and the other with an induction of lower pressure, which will be called into play on those stretches only where the speed is to be reduced. With such a double equipment of motors it will be possible to meet the requirement of greater tractive power when it is necessary to reduce the speed of the train.

It is an economic truism that the proper method for Italy to pursue is to develop those industries for which she has all the facilities within her own borders. These have been shown to be included in the departments of metallurgy, industrial technology and transportation. The mineral wealth of the country can be developed, transformed, utilized or delivered for export, all by the utilisation of the natural sources of power within her borders, to the great benefit of the whole population as well as to the increase of the wealth of the state.

ENGLISH AND AMERICAN LOCOMOTIVE BUILDING.—II.

By Charles Rous-Marten.

BEFORE entering upon the second phase of my subject I should like to point out once more that my remarks are intended to have simply a *general* application. I do not assert or imply that there are no deviations from the practices which I am about to mention as prevalent respectively in Great Britain and in the United States of America. I merely desire to make it plain that such deviations are exceptions to an otherwise prevalent rule. For instance, the single driver system may be said to belong emphatically to British practice and not to American. Yet America has built two single-wheelers at any rate which have won considerable fame in their day, viz., the Eames engine, which was sent over to England some years ago in connection with brake-trials, and the more recent "No. 385," which, I believe, is still working with success. Nevertheless I might reasonably instance the case of single-wheelers in Great Britain as one prominent divergence in respect of practice, on the ground that this is not an American custom. In short my observations must be taken as dealing with the *rule*, not as denying the existence of occasional exceptions.

Another preliminary remark which I desire to make is that I cannot pretend, within my present limits of space, to enter into the more minute details of construction. These would require a whole volume, not a mere article. Therefore I must confine myself to salient features and general terms.

It would appear reasonable to begin my analysis with the virtual foundation of the locomotive—its frame. Here at once we are confronted with an entire difference between the methods of the two countries. In England plate framing is practically universal. In America bar framing is equally the prevalent rule. Yet, curiously enough, the latter system did not originate westward of the Atlantic. It was largely adopted by Mr. Bury in the early days of railways in England, and may be said to have gone out with him and his peculiar style of locomotive. Mr. Bury was a somewhat strong-willed, and in the opinion of some of his contemporaries wrong-headed, man. He unquestionably impeded and prejudiced the London & North Western Railway in its early days by his obstinate adherence to his small

four-wheeled type of locomotive, when the growing traffic already had imperatively called for the larger six-wheeled engines that were used on other lines. In the end the stern logic of hard fact was too strong for Mr. Bury, and he had to go. His toy locomotives with their curious round fire-boxes and high copper domes, like small haystacks, over the fire-boxes, were speedily relegated to inferior duty and were replaced by more powerful machines. With Mr. Bury and his "haystacks" went also bar-framing, so far as England was concerned.

It is no part of my function to pronounce judgment here upon the relative merits of the two methods. Each seems to possess its own advantages, but the difficulty of appraising their respective value is greatly enhanced by the extraordinarily diverse theories put forth by their respective advocates. Within my own knowledge a sharp controversy took place on the subject several years back between eminent engineers on opposite sides of the Atlantic, in relation to the question of the preferable build of locomotives for employment on rough colonial lines.

An order had been given for some American engines, it being held that these would be most suitable to colonial roads hastily and cheaply constructed, with light permanent way, steep gradients and frequent sharp curves. A British engineer took exception to this view and contended that the superior strength and rigidity of their plate-framing rendered British engines far safer and more economical on a rough and light road which necessarily made the utmost demand upon stability and endurance. He condemned the American bar-framed locomotives as "loose jointed affairs resembling so many wicker baskets." He was promptly answered by an American engineer who twitted him with utter ignorance of the primary conditions involved. "It is quite true," he said, "that our American engines may be compared to flexible wicker baskets—*but therein lies their merit.* They are so flexible that they glide easily over rough roads and round sharp curves on which a stiff, unyielding British engine would soon knock itself to pieces. It is the remarkable flexibility of an American engine that renders it so supremely suitable to new countries with their light-built and curved lines."

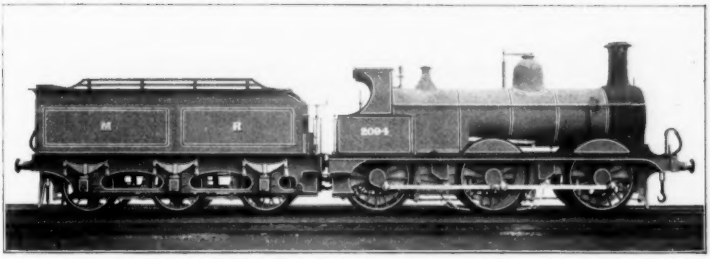
Now the matter might conveniently have been left here as illustrating a vital divergence of engineering opinion and a rudimentary but important point—that is to say, whether rigid or flexible locomotives were better suited to light, rough, curved roads. A new and fearful complication was introduced however by a second American

engineer, who "went for" both the previous writers "with the gloves off." The bare suggestion that the American engine was a "loose-jointed affair," nay, even that it was more flexible than the British machine, filled him with derision. Every child knew, he practically declared, that the bar-frame of an American locomotive, instead of being more flexible than the plated frame, was infinitely stronger, stiffer and more rigid. Therein, he maintained, lay its merit. You did not want an engine to go bending and twisting itself all over the place, however rough the road might be. Indeed the rougher the road the less the engine ought to bend and wriggle. What you wanted was in effect an engine that was so strong and stiff that it could ride roughshod over all curves and inequalities and weak rails and slight permanent way. The grand advantage possessed by the bar-framed locomotive was its remarkable firmness, strength and rigidity. Nor would he admit that these advantages applied only to light and rough roads. Clearly, he urged, the engine that did so well on bad roads must do even better on good tracks. Therefore, he concluded, the bar-framed engine was the best for all roads and purposes.

It is needless to pursue the controversy, in which no two of the disputants could agree even as to the premises. Nor is it necessary to mention that not one of the disputants was in the smallest degree shaken in his own opinion by the demolition which in the opinion of the other two participators in this "triangular duel" was so complete and crushing. The ultimate outcome of the somewhat comic wrangle was to leave the whole question an open one.

Personally, as I have said already, I am indisposed to record my vote on either side. I have had many opportunities of observing both systems in operation and I candidly confess that one seems to me to give in practice as good results as does the other. And the fact remains that American engines as a rule have bar-framing—British engines plate-frames.

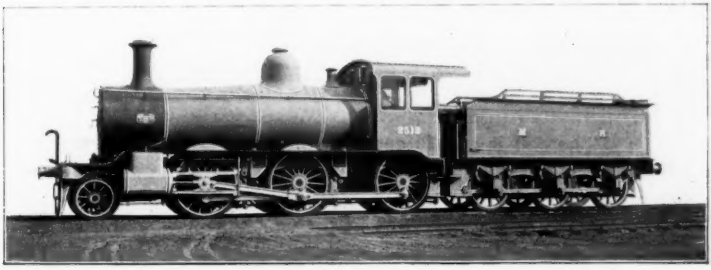
Another very prominent difference between British and American locomotive practice is that American designers prefer to place as many as possible of the working parts *outside;* whereas the British plan is to put everything *inside*. Here again we have diametrically opposite methods, and here again there is much to be said on both sides. On behalf of the American method it may fairly be urged that much is gained in respect of the easy accessibleness of the working parts for examination and manipulation when required. Against this system it may be contended with equal fairness that the outside position involves greater exposure to variation of temperature—especially to



ENGLISH GOODS ENGINE, MIDLAND RAILWAY.

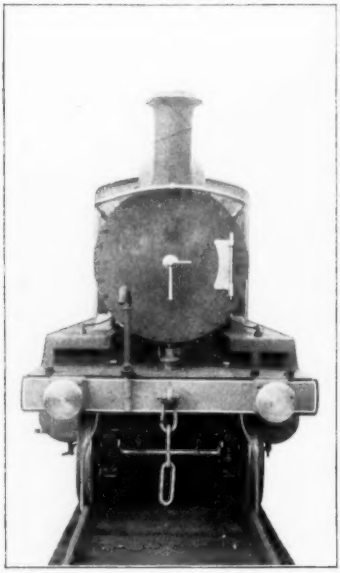
cold air in winter, and to dust, etc., while the lateral dimensions of the engine are augmented to an extent often inconvenient and undesirable when, as in England, the limitations of space are so materially restricted as compared with those available on the American and European Continents.

The extent to which this drawback operates in British locomotive designing is seldom adequately appreciated. Yet the difference is so large that whereas in the United States the loading gauge permits a height of fully 15 feet, and an extreme breadth of 10 feet 3 inches, in Great Britain the height cannot exceed 13½ feet, and the extreme breadth 9 feet. The penalty for excess in height would be that the peccant locomotive would have its chimney knocked off by the first bridge or tunnel that it entered, while excessive width would involve disastrous collision with the platform of the first station entered. The loading gauge on the European Continent may be taken roughly as intermediate between those of Great Britain and the United States of America.

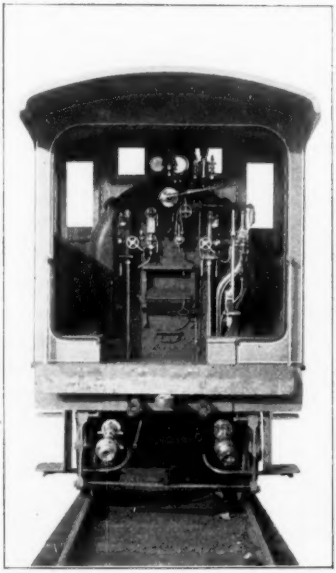


AMERICAN GOODS ENGINE FOR MIDLAND RAILWAY. BUILT BY SCHENECTADY LOCOMOTIVE WORKS.

It will therefore be readily realised that American and even European dimensions are not feasible in British locomotives, and that structural disabilities thus exist in the latter case which no ingenuity of designers can overcome. Apart from this insuperable obstacle, however, it may be admitted that British opinion prefers the inside method as inducing superior neatness and symmetry of external appearance. There is unquestionably an attraction to the temperament of the British engineer in the concealment of his *modus operandi*. His

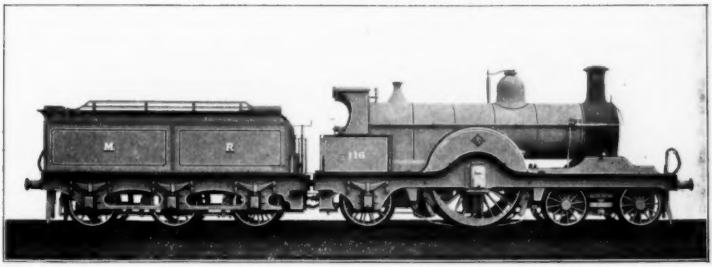


FRONT VIEW OF SCHENECTADY ENGINE FOR MIDLAND RAILWAY.



REAR VIEW OF SCHENECTADY ENGINE FOR MIDLAND RAILWAY.

engine runs along as if of its own volition. No sign of its motive power is permitted to appear externally. All outside is symmetrical neatness. The *end* is visible enough; the *means* are studiously kept out of sight. There is a certain charm as of unseen potency about this arrangement and the æsthetic superiority seems unquestionable. Nevertheless the free accessibility of the working parts and their constant visibility must be admitted to possess elements of safety as well as of convenience. It will barely be pretended that working gear can be so easily and efficiently examined from underneath the engine in

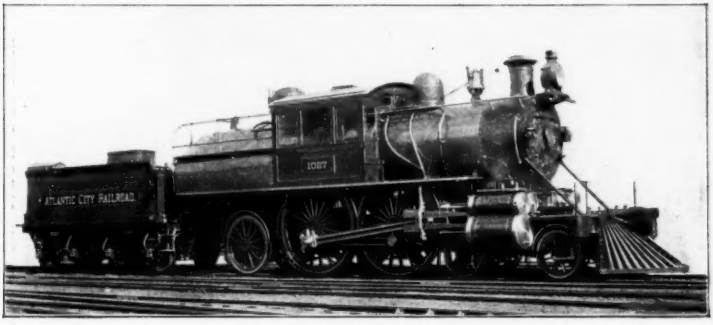


ENGLISH EXPRESS LOCOMOTIVE, MIDLAND RAILWAY.

darkness illumined only by a hand lamp, as outside in full daylight or under the glare of the brilliant lights of a station. The point is, as usual in engineering problems, whether this advantage is or is not too dearly purchased at the cost of drawbacks in other respects.

Here, again, bearing in mind the wide difference of opinion that exists on this point among the highest authorities I do not feel warranted in recording a verdict. Instead of pronouncing judgment on a point as to which the most competent judges differ *toto coelo* I prefer to deal a little more fully with one detail upon which virtually the whole matter turns.

Practically the issue resolves itself into that of inside *versus* outside cylinders. For if the cylinders be outside then most of the working gear will have to be outside also, and *vice versa*. Here it is a case of "Athanasius against the world," and Great Britain is the Athanasius.



EXPRESS LOCOMOTIVE, ATLANTIC CITY RAILROAD.

This engine, built by the Baldwin Locomotive Works on the Vauclain compound system, hauls the fastest train in the world, regularly making the run from Camden to Atlantic City, 55½ miles, in 50 minutes.

OFFICES AND TOP YARD, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

BOTTOM YARD, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

While the rest of the world votes almost "solid" for outside cylinders, England is practically unanimous in adopting the inside position. In fact the *sole* exceptions to this rule on any leading railway in the whole United Kingdom—as regards modern engines—are confined to cases of exceptional design which render outside cylinders absolutely imperative. The only cases of outside cylinders being used in engines of modern design on any British main line are the following: (1) Mr. Patrick Stirling's 8 feet single-wheelers on the Great Northern—outside cylinder necessitated by height of driving axle. (2) Mr. F. W.

LOCOMOTIVE YARD FROM STATION ROOF, MIDLAND RAILWAY, DERBY.

Webb's three-cylinder and four-cylinder compounds on London & North Western—high-pressure cylinders necessarily outside owing to space between frames being ocupied by low-pressure cylinders. (3) Mr. H. A. Ivatt's ten-wheeler, No. 990—cylinders placed outside to get both pairs of coupled driving wheels in front of fire-box with view of obtaining augmented length of fire-box with pair of carrying-wheels 1619, for virtually same reason as in case of Mr. Webb's compounds, behind. (4) Mr. Wilson Worsdell's three-cylinder compound, No. and (5) Mr. Wilson Worsdell's new six-coupled express engine be-

ERECTING SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

ERECTING SHOP, SCHENECTADY LOCOMOTIVE WORKS.

BOILER MOUNTING SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

BOILER ERECTING SHOP, SCHENECTADY LOCOMOTIVE WORKS.

IRON FOUNDRY, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

IRON FOUNDRY, SCHENECTADY LOCOMOTIVE WORKS.

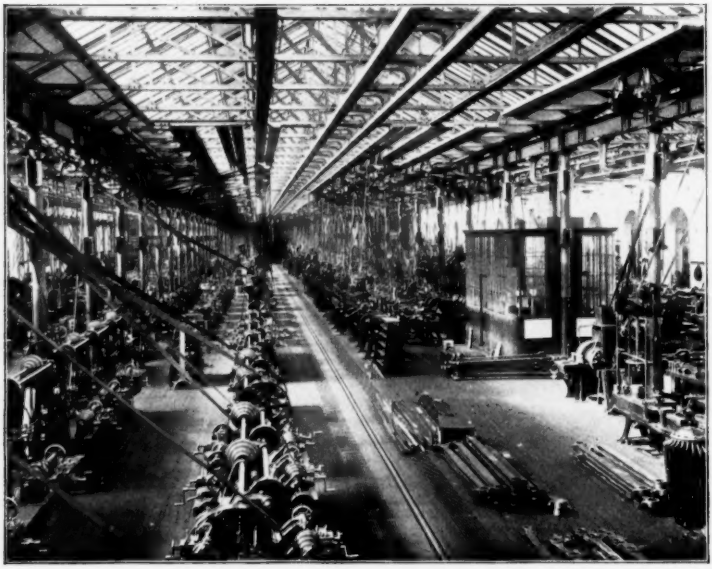
cause of difficulty in placing cylinders inside and having the connecting rod clear the axle of the first pair of coupled wheels.

Few points in locomotive construction have been the subject of stronger dispute than this one of the position of cylinders. The advocates of the outside position claim that by placing the cylinders outside the frame, not only are they far more easily accessible, but also a straight driving axle can be used and the crank axle with its essential

MACHINE SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

weakness of form, can be dispensed with. It is pointed out that if a double-crank axle be set up on end and regarded as a column it manifests about the weakest shape that could be devised, and one which possesses the minimum of strain resisting capacity, especially as compared with a straight axle consisting of one homogeneous bar of steel.

All this is practically indisputable. But the reply, as usual in such engineering cases, is that the unquestionable advantages may be too dearly bought. Putting aside, as a merely æsthetic matter, the supe-



MACHINE SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

MACHINE SHOP, ROD WORK, SCHENECTADY LOCOMOTIVE WORKS.

BLACKSMITH SHOP, FRAME WORK, SCHENECTADY LOCOMOTIVE WORKS.

BLACKSMITH SHOP, SCHENECTADY LOCOMOTIVE WORKS.

PAINT SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

rior compactness and neatness in appearance of an inside cylinder engine, it is contended that the outside position for cylinders has several structural disadvantages. In the first place the cylinders are so far apart that the pull of the pistons and piston-rods is at the farthest possible point from the middle line of the engine. In these circumstances the alternate reciprocating motion of the pistons and rods must needs set up in a greater or less degree a "punching" or "boxing" action which is obviously prejudicial to the steadiness of a locomotive and consequently tends to increase the wear and tear. That this detrimental action may be, and has been, reduced to a large extent through modern improvements in construction is undeniable. Nevertheless the "punching" action must always remain even if in a small degree, where outside cylinders are employed. Its influence may be slight but it is there *quantum valeat.* In this respect the superiority of the inside cylinder with its direct middle pull is manifest.

Secondly it is argued that the outside position exposes the cylinders unduly to vicissitudes of temperature and especially to cold. The pas-

sage of the engine even through a still atmosphere at a speed of 60 miles an hour or more involves virtually the rushing of a cold gale or even hurricane over the whole of the exposed external surface of the cylinders. Clearly this must cause some loss by condensation. Indeed the fact is implicitly admitted. Steam-jacketing has been suggested and tried as a corrective of this drawback to outside cylinders, but the results obtained so far have been somewhat discrepant, one engineer claiming to have gained an advantage equivalent to an additional half-inch in his cylinder's diameter, while another finds no benefit at all to accrue from steam jacketing. In either case the fact remains that outside cylinders do possess this disadvantage of exposure and excess of condensation.

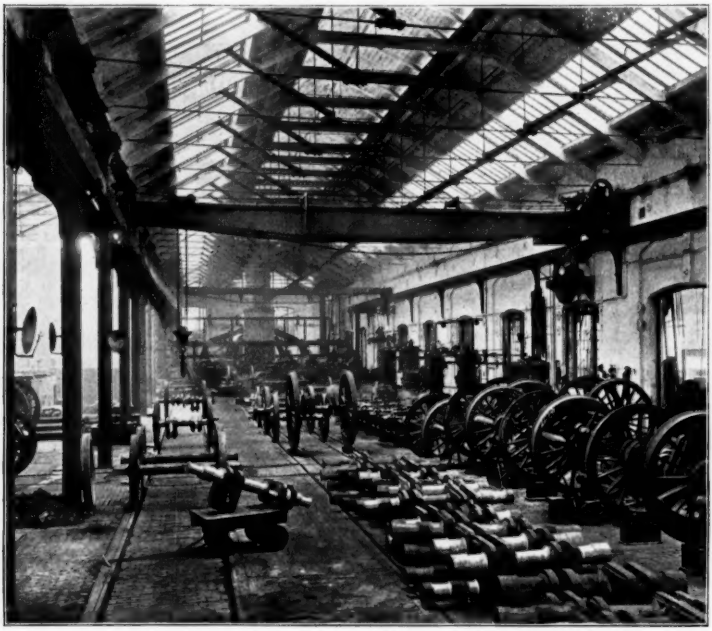
A third consideration which has operated in securing the use of inside cylinders in Great Britain wherever feasible is that the alternative course necessitates a stronger and heavier and therefore more costly mode of construction. A moment's thought will show that it is much easier to fix two cylinders stably as a single block of metal between the two frames, than to attach each cylinder separately to the outside of one frame and yet to give it as much stability as if placed

CYLINDER SHOP SCHENECTADY LOCOMOTIVE WORKS.

inside. This can only be achieved by means of a somewhat more expensive mode of construction.

But the advocates of inside cylinders do not stop here. Some of them boldly deny the existence of any greater weakness in the cranked axle than in the straight one, and even assert that the latter possesses a peculiar weakness of its own.

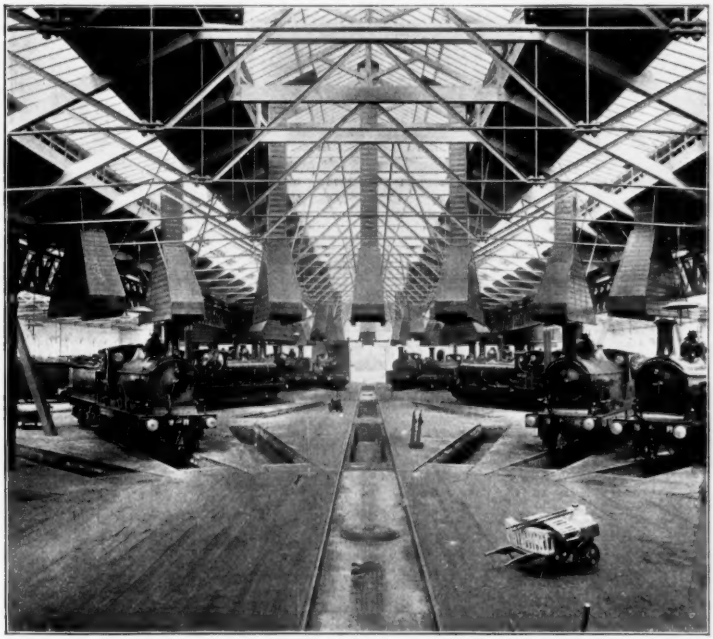
The late Mr. William Stroudley, a former locomotive Superinten-



WHEEL SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

dent of the London, Brighton & South Coast Railway, expressed during a conversation with me on this point, very strong views to the effect just now indicated. "A crank axle does not break *because* it is cranked," he said, "if it be properly designed and constructed of good material and in due proportion. Its shape has no inherent weakness for the purpose it is intended to fulfill, if these essential conditions are duly observed. Fractured crank axles are usually found on examination to have had some flaw either in design or material, or construction. I have not (he continued) found them break more

frequently than straight axles if even so often. You must remember that the straight axle is turned by a power applied to its extreme ends and that it does not move until the utmost strain in the direction of torsion has been applied to it. That torsion must have a tendency to loosen the fibres of the metal, and so to weaken the axle, while if any hidden flaw should exist this same action would be most apt to find it out and led to fracture." The late Mr. Patrick Stirling, locomotive superintendent of the Great Northern Railway, was another



NEW SHED, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

thorough-going advocate of inside cylinders, although he designed and built some of the most famous outside cylinder engines known in railway history, the 8 feet single-wheelers. "But I only used outside cylinders," he said to me, "because I could not have inside ones with such a large wheel (8 ft.) and so long a piston stroke (28 in.). It was essential to my design to employ these dimensions and so I had to use outside cylinders and a leading bogie also, neither of which I should have adopted could I have avoided doing so." Even Mr. William

TANK SHOP, SCHENECTADY LOCOMOTIVE WORKS.

Adams, long the most eminent "outside cylinderist" in England, ultimately abandoned the plan in every class of engines excepting those for the fastest express work. In the latest years of his rule on the London & South Western Line he designed and constructed four different classes of inside cylinder locomotives, two tender and two tank, one reason being, I believe, their superiority in point of cheapness.

But in the case of his 7 feet and 6 feet 6 inch coupled express engines, Mr. Adams, to the last, used outside cylinders—a course which has been reversed by his successor—and in various conversations with myself he justified their use on the ground that notwithstanding the disadvantages already pointed out, which he frankly admitted to exist, the advantages of easy accessibleness and of a straight axle were sufficiently great to compensate for all drawbacks. This too is the view held by nearly all American engineers and by most European continental ones also. It will therefore be recognised that here, as in the case of the bar and plate framing, we have a distinct and radical difference between British and American methods in construction. And here again I may remark that it does not fall within my province to adjudicate between the two systems.

Pursuing my analytical examination I come next to a group of differences which may all be classed under the head of economy in prime cost as against superior durability. In the United States the fire-boxes and boiler-tubes of locomotives are usually constructed of steel. In Great Britain the fire-boxes are almost invariably made of copper and the tubes of brass or copper. Obviously, steel being a far cheaper material, steel tubes and fire-boxes will cost much less than brass or copper tubes and copper boxes. But the latter are far more durable and so in accordance with that British preference, on which I enlarged in my previous article, for everything that is lasting and durable, the more costly material is employed as a matter of course.

In America on the other hand, similarly carying out the principle mentioned in the same article, steel tubes and fire-boxes are used because, while they cost less, they are found to be quite good enough for the purposes they are intended to serve. The American engine while it lasts is quite as good a machine and quite as efficient per unit of nominal power as the British locomotive, only it will not last so long. And the American engineer says with much emphasis and reason that he does not want it to last so long because it must in a decade or little more become virtually obsolete and block the way of more modern and up-to-date machines with which he would like to replace them. And so he contents himself with his cheaper steel tubes and fire-boxes and gets as much work out of them as his British *confrère* does out of his more expensive brass or copper. By the time the steel tubes and boxes are worn out he is almost ready for a new engine. It is no doubt true that brass or copper tubes and copper boxes are more economical in respect of repairs. But as in the case of cylinder-position the engineer, British or American, holds that his own method, if it has some disadvantages, is on the whole a better one.

Much the same may be said of the cast-iron wheels with chilled rims, so largely employed in American practice. The position of the sand-box—over the boiler in America, in front of the driving wheel in England—is a detail of hardly sufficient importance to discuss at length. The superiority of the American cab in respect of the comfort and convenience it affords to those engaged in working the engine and the greater facility with which it therefore enables them to perform their important duties seem to me indisputable. But some British railways are following the example of the United States in improving their cabs, notable instances being afforded by Mr. Wilson Worsdell's clerestoried cabs, on his new North Eastern engine and by Mr. J. T. Macintosh's roomy and commodious cabs on his Caledonian "Dunala-

stairs" and "Breadalbanes." So here again no actual international difference can any longer be predicated.

The use of the four-wheeled leading bogie is now universal in the case of new British engines, and I may observe in passing that, like bar-framing, so often believed to be an American invention, the bogie too had its origin in the Mother Country. The bogie tender is, I believe, a strictly American idea, but it has found its way to Great Britain and I suspect that it has "come to stay." It is established at any rate on the Caledonian, Glasgow-South-Western and London-South-Western lines, and is coming on the Midland also. In respect of valve gear, single or double slide bars, plain or fluted side rods and many other details, each country has a large diversity of practice, and none of these can be cited as peculiar to either country.

But while Great Britain and America both freely use the fluted coupling rods, which I believe Mr. T. W. Wordsell, when locomotive superintendent of the Great Eastern Line, was the first to introduce, in 1884, America, so far as I am aware, stands alone in fluting also the connecting rods, although the augmentation of strength proportionally to weight manifestly accrues in one case almost as much as in the other.

Hitherto the wagon-top design of boiler has been, I fancy, peculiar to America, while the flush-top boiler has been a British specialty. But the Belpaire fire-box is gaining ground rapidly in Great Britain on account of its superior capacity for steam generation, and I understand that it is gaining considerable acceptance also in the United States. At all events the Belpaire system does not constitute a point of marked difference between British and American practice, and the prevalence of the flush boiler on our side of the Atlantic and of the wagon top on the other shows a distinct tendency to diminish in each case in favor of the Belpaire plan.

There was a time when the chimney offered an infallible indication of British or American parentage. But "we have changed all that." The huge inverted cone and the double cone (or "diamond") surmounting a cylindrical column which used to be the typical American "smokestack" as contrasted with the plain cylindrical flue, often flanged at the top, which still remains the regular British "funnel"—though utterly unfunnel like in shape—have been succeeded by a chimney which differs little if at all in general design from that seen in Great Britain. The extended smoke box which in America replaced the single inverted or double cone as a spark catcher, has traveled now to Great Britain as well, and may be found on the Great Western,

North Eastern and Glasgow-South-Western lines. It is no longer an Americanism.

In short the distinctive features of the British and American systems are now but few. Their tendency is to become fewer still. It is true that such at present exclusively American designs as the "Consolidation" (8 wheels coupled and 2 wheeled bogie) "Decapod" (10 wheels coupled) "Twelve-wheeler" (8 wheels coupled and 4 wheeled bogie) "Columbia" (four wheels coupled with leading and trailing 2 wheeled bogies on the Vauclain compounds) have not yet found their way to England, nor the inside-cylinder single-wheeler or the Webb compound to the United States, while the only "Mogul" engines (6 wheels coupled and 2 wheeled bogie) built in England by Mr. W. Adams for the Great Eastern Railway have been condemned and broken up; but there is I think a growing tendency toward assimilation between the systems of the two English speaking nations, so far as this is feasible in view of the difference in the conditions to be satisfied. England has not the long journeys of America or the American loading gauge space which would permit of large vertical or lateral extension of existing maximum dimensions. But I certainly anticipate that the present importation of the Midland, Great Central and Great Northern line of American Mogul goods engines will have an appreciable influence upon the future of British locomotive engineering.

In a third article I hope to be able to give some information as to the immediate results of the experiment. I shall at the same time touch upon a few other points of difference between American and British locomotive practice, which limitations of time and space compel me now to postpone. I append to the present article some illustrations of Midland locomotives and of the famous Derby works of the same English line, reproduced from some very fine photographs for which I am indebted to the courtesy of Mr. S. W. Johnson, the able locomotive superintendent of that important line. Acknowledgments are also due to the Schenectady Locomotive Works, of Schenectady, New York, U. S. A., and the Baldwin Locomotive Works, of Philadelphia, U. S. A., for the use of photographs of engines and works.

THE WITWATERSRAND MINES AND THE BOER GOVERNMENT.

By Frederick H. Hatch.

THE political phases of the South African situation have been so pushed into prominence recently, and the party feelings, seemingly inseparable from political differences, have run so high, that there is danger of losing sight of the fact that the fundamental question is not one of politics at all, but of engineering industry and economics.

It is of the freedom—perhaps of the existence—of mining enterprises whose prosperity touches closely the professional, the manufacturing, and the financial world. In this article an attempt is made to show what are the heaviest burdens now pressing on the mining industry of the Rand, and preventing the attainment of the full measure of success presaged by the unequalled natural conditions and justified by the careful study and advanced practice of the owners and managers.

The Witwatersrand mines produced last year gold bullion having the value of fifteen million pounds sterling, being 28 per cent. of the world's total output. This result was obtained from the operation of seventy-seven companies, having an average aggregate milling power of 4,765 stamps. The properties of the majority of these companies are situated on the outcrop of the gold-bearing conglomerate beds, only eleven so-called "deep-level" companies having been at work during the year. As the other deep-level properties, now being developed on the second and third rows of mines, come into operation, the output will be very largely increased. It is estimated by good authorities that, during the next five years, the number of stamps dropping will be increased to more than 12,000.* Since the average duty of a stamp in the Witwatersrand mills is 1,500 tons per annum, 12,000 stamps would crush 18,000,000 tons of ore yearly. On the assumption that the ore will maintain its present grade, namely between nine and ten dwts. of fine gold or, say, forty shillings to the ton—the output from the Witwatersrand fields would, on this basis, amount to thirty-six million pounds sterling per annum.

It is the great results already obtained and the still greater prob-

* See the Annual Report of the Rand Mines Co. Lim., for 1898, p. 38.

abilities of the future that have focused the attention of the mining and financial world on the Transvaal, and have drawn to the Rand, from all parts, that immense population of busy workers who make up the body of the "Uitlanders," or foreigners, and form such a marked contrast to the older but less progressive Boer population. In consequence of the marvellous success of the goldfields the pace has become too rapid to please the Boers, who find themselves in danger of being swamped in the crowd of foreigners. Already, according to official returns, the Uitlanders outnumber the Boers in the proportion of at least three to one.* Hence the efforts of the Boer autocracy to maintain their present supremacy.

But the Transvaal owes its flourishing economic position solely to the industry of the Uitlanders, its industrial development dating from the discovery of the gold-bearing conglomerates of the Witwatersrand in 1885. The revenue of the South African Republic for that year was £117,876. By 1897 it had increased to £4,480,217 and last year it was £3,983,560. This revenue is derived, either directly or indirectly, almost entirely from the activity of the Uitlander population and the greater part of it has its source in the Witwatersrand mines.

On first thought one would have imagined that, in a country whose prosperity is so entirely dependent on the success of a growing industry, it would have been the prime care of the Government to foster and assist, in every way possible, that industry in its development. But the Boers take another view. The progress of the fields is hampered and impeded by heavy taxation and monopolies, and, what is perhaps still worse, the huge revenues are squandered in the erection of military forts, in the purchase of arms and ammunition, and in other similarly useless expenditure, instead of being laid out on railways, roads, irrigation, and other works calculated to develop and improve the country. The Uitlanders, being debarred from political rights, have no voice in the direction of affairs, and see with increasing disgust and impatience this waste of the resources of the country.

In the early part of 1897 a commission was appointed by the Transvaal Government to enquire into the grievances of the Witwatersrand miners. The evidence given before that commission showed that the cost of working the mines was unwarrantably high, in view of the existing favourable conditions and of the highly organised methods employed. Further, that this high cost was due to the ex-

* The *Staats Almanak*, an official publication, gives the male Boer population as 29,279, and the male Uitlander population as 137,121.

tortionate carrying rates of the railways, to the exactions of the dynamite monopolists, and to the inefficiency of the native labour.

The cost of working, averaged for all the mines, was in 1897 about 29 shillings and 6 pence per ton milled. Since then some slight reductions have been made, principally in native labour, bringing the average for 1898 down to 28 shillings. This cost is arrived at by deducting the dividends paid from the value of the total production, a severe but serviceable method of calculation.

It was shown to the commission that the different items of expenditure represented at that time the following percentages of the total:

White labour	30	per cent.
Native labour	23	"
Explosives	10	"
Coal	8	"
Stores	19	"
General charges	5	"
Total	100	"

We will take each of these items *seriatim* and endeavour to show what economies have been effected since the time of the commission.

Under the item white labour are included all white employees from the manager downwards. The number of white men now employed on the mines is nearly 10,000, as against 8,000 in 1897, and the average rate of wage is at present £26 per month, as against £24. In view of the high cost of living on the Rand, there is little hope of any reduction being made in this direction; indeed, the average wage now paid is, as shown above, even higher than it was in 1897.*

Natives (*i. e.*, Kaffirs from various parts of South Africa) are employed on the mines for all kinds of manual work, such as drilling, shoveling, filling, tramming, firing, etc. They outnumber the whites in the proportion of nine or ten to one, there being at present from 90,000 to 100,000 black employees. The average rate of wage per head is at present about £2 10s 0d per month, to which may be added another 10 shillings for food; for besides heir pay, the natives employees are housed and fed at the expense of the companies. In 1897 the average cost per "boy" was about £4 per month, so that already a considerable saving has been made under this head.† The quality

* A recent report of the Rand Mines Co. shows that the cost of white labour for 1898 was 34.5 per cent. of the total expenditures on these mines, as against 32 per cent. during 1897.

† The cost of black labour in the Rand Mines Co. during 1898 was only 15 per cent. of the total expenditure.

of the labour, however, has not improved and leaves much to be desired. A considerable percentage is rendered unserviceable by the demoralization produced by the sale of liquor to natives by the canteen keepers; for, although the sale of liquor to natives is forbidden by law, this traffic is, by reason of an incompetent or corrupt police administration, one of the chief grievances of the mine officials. The supply of native labour also causes much trouble, as it does not keep pace with the ever increasing demand, caused by the opening up of new deep-level properties.

Explosives comprise dynamite, fuse, and detonators—dynamite, however, being 95 per cent. of the whole. As is well known, the supply of dynamite is in the hands of a monopolist company, the South African Explosives Company, which is controlled by the European manufacturing firm of Nobels. The present price of dynamite (No. 1), at the company's factory at Modderfontein, on the Rand, is 75 shillings per case of 50 lbs., out of which the Government receives two shillings and six pence in lieu of a share of profits. Although the price has been reduced by 10 shillings within the last eighteen months, it is still excessive; for, before the present monopoly was obtained, Nobels offered to deliver dynamite in bond at Johannesburg at 40 shillings the case, and the same people are at the present time receiving 37 shillings and 6 pence per case from the De Beers Company in Kimberley. The consumption of dynamite on the Rand is now about 250,000 cases per annum; consequently, with free trade in explosives, a saving of over £400,000 per annum might be made without reckoning the additional saving to be made on an increased consumption. Even the reduction of 10 shillings per case, which was made in May, 1898, can be of no great benefit to the industry; for it was effected by the Government abandoning the royalty of 5 shillings per case to which it was entitled under the contract, the Company conceding the other 5 shillings.* On a consumption of 250,000 cases there is a loss of £62,500 per annum, which as the Government is in want of funds, must be met by the imposition of fresh taxes in other directions.

The consumption of coal by the mines has acquired great dimensions, the tonnage sold by the collieries in the Transvaal in 1898 amounting to 1,940,000 tons, the larger part of which went to the gold mines. The average distance the coal is carried to the mines is 25½ miles, over a perfectly flat country; for this carriage the Netherlands

*That the high cost of dynamite is still a heavy burden is shown by the fact that the cost of the explosives used by the Rand mines subsidiary companies amounted to 12 per cent. of the total expenditure during 1898.

Railway Company make a charge of 4 shillings and 5 pence per ton, or 2.08 pence per ton per mile.* At the time of the investigations of the mines commission, the freight averaged 3.3 pence per mile; but the reduction, although considerable, is inadequate. Compare, in this respect, the Transvaal with the United States, where the average rate for coal transport, over all sorts of roads, is less than a halfpenny per ton per mile.†

Stores include cyanide, zinc, timber, steel, lubricants, candles, ropes, machine spares, and sundries, the cost of which is heavily increased by existing high railway rates. The same applies to machinery,

General charges comprise insurance, claim-licenses and rent, printing and advertising, and sundries. No reduction has been made under this head; on the contrary, expenditure has been increased by the imposition of a 5 per cent. tax upon the profits made by mining companies working ground other than mynpachts,‡ while companies working mynpachts are to contribute 2½ per cent. of their gross yield. Mr. Rouliot§. President of the Johannesburg Chamber of Mines, has given the following figures illustrating the effect of the new taxes: During 1898, 28 companies obtained gold from mynpachts to the value of £5,474,787. The proportion of this accruing to the Government, being 2½ per cent. of the gross value, would be £136,870. Regarding the 5 per cent. tax, Mr. Rouliot estimates that the figure £2,971,631 represents the total profit made by companies, exclusive of those working mynpachts. The 5 per cent. claimed by the Government would therefore be £148,580. The two new taxes thus amount together to £285,450, contributed by seventy-seven companies, having a total issued capital of £29,100,000; the new taxes therefore amount to nearly 1 per cent. on that issued capital. The increment to the cost of working amounts to 9.3 pence per ton milled. The Chamber of Mines protested against the tax on profits, on the ground that it was unnecessary and unjust; unnecessary, because a budget of 3½ millions sterling ought to be sufficient to govern a country with a white population of less than 300,000; and unjust, because it comes in the face

* The tariff for the conveyance of coal from the collieries to the mines on the reduced scale ranges from a maximum of 3 pence to a minimum of 1.569 pence per ton per mile — Vide Chamber of Mines Report for 1898, p. 213.

† The cost of coal used by the Rand mines during 1898 was 7.7 per cent. of the total expenditure.

‡ A mynpacht is a piece of ground marked off by the original owner of the farm when it was proclaimed, being one-tenth of the amount proclaimed, and held by him under mining lease from the government. The rental was fixed at 10 shillings per morgen, but the government reserved the right to demand in lieu of this rent 2½ per cent. of the gross yield.

§ In a speech delivered at the general meeting held on the 28th of January of this year.

of official reports* recommending reductions to the burdens pressing on the industry, which already contributes at least five-sixths of the State revenues.

Having reviewed the position of the mining industry, the question arises; what are the changes necessary to effect further economies in the cost of working, in order to improve the position, to enable those companies that are at present working at a loss to show a profit, and to allow other lower-grade properties, now lying in abeyance, to be again taken in hand and brought to a successful issue? Engineers and mine-managers have done their utmost to reduce working expenses to a minimum, and their efforts have achieved a considerable measure of success. Without assistance from the Government, however, they can do little more, but assistance means, in this case, not any artificial aid, but the removal of artificial hindrances. The most pressing reforms required are; the expropriation of the monopolist railway, the cancellation of the dynamite monopoly, the suppression of the illicit liquor traffic, and last, but not least, a voice for the Uitlander in the expenditure of the State revenues.

At the present moment the burning question of the extension of the franchise to the Uitlanders, occupies public attention to the exclusion of the other grievances. There is no doubt that many of the existing evils would find their remedy if the industrial population were admitted to an adequate representation in the governing body. At the time of writing, such representation seems as far off as ever, but until it is obtained, dissatisfaction and unrest will be rife in the Transvaal.

* The Mine Commissioners, appointed by the Government to enquire into the grievances of the industry, stated in their report that they considered it "the duty of the Government to co-operate with the mining industry and to devise measures with a view to make it possible for lower-grade mines to work at a profit, and generally to lighten the burdens of the mining industry."

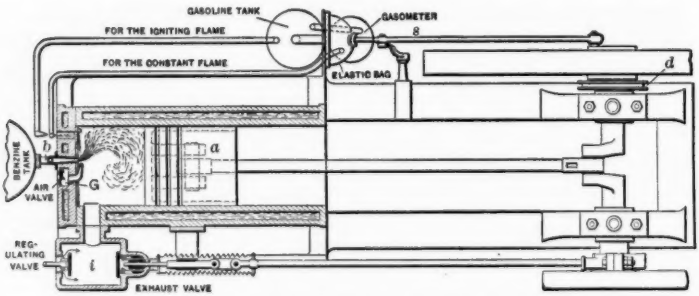
EVOLUTION AND FUTURE OF BENZINE AND PETROLEUM ENGINES.

By G. Lieckfeld.

THE inventors of the first gas engines were aware that their engines could be driven with liquid fuel, and these ideas led to the first models of benzine and petroleum engines.

In 1838 William Barrett stated in the patent specifications of his gas engine that the machine could also be driven with the volatile hydrocarbons; showing that at this early date the possibility of utilizing this form of fuel was already known. Nearly forty years passed, and it was about the year 1873 that Julius Hock, a machine builder of Vienna, began commercially to manufacture and sell a practically working and reliable benzine engine; one which was built extensively in Germany and other countries.

This was a single-acting piston engine, very similar in its action to the Lenoir gas engine. In the early part of the stroke the piston drew in atomized benzine through the nozzle *b*, and air through the valve



GENERAL ARRANGEMENT OF BENZINE MOTOR.

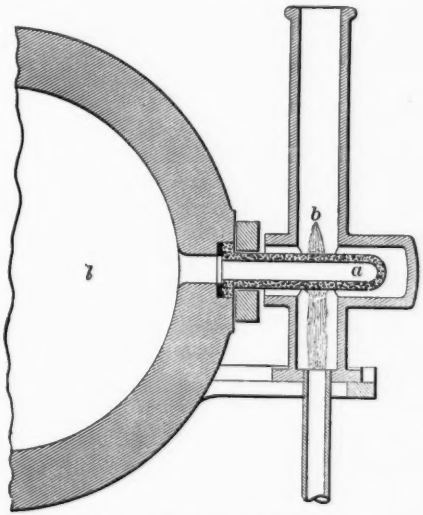
g. This mixture was ignited and the resulting explosion drove the piston to the end of its stroke. An exhaust valve then opened into the chamber *i*, and on the return stroke the products of combustion were expelled.

The Hock engine was the first of the explosion engines to use the open cylinder with direct transmission of power from piston to crank, and this form is still in general use. Although the Hock engine was

soon superseded, it had sufficient merit to serve as a model, in many respects, even for the latest compression gas engines.

The next improvement followed in 1876 with the benzine engine of the American, Brayton. In this machine, soon displaced by improved models, the mixture of benzine vapor and air was not exploded, but slowly burned behind the advancing piston. The back flash of the flame into the mixing chamber was prevented by a fine wire screen.

Very shortly after the appearance of the Otto compression gas engine attempts were made to adapt it to the use of benzine, but the



DAIMLER IGNITION TUBE.

igniting apparatus in use at that time was not a success with the liquid fuel.

Benzine engines gave no promise of success until after the invention of the ignition tube by Daimler, in Cannstatt. In all previous explosion engines the igniting apparatus was complicated and uncertain, but this striking invention of Daimler made it most simple and sure. The older form of flame ignition required constant attention, but the incandescent tube works automatically and with the greatest precision. It consists essentially of a tube, *a*, closed at one end, and with its open end fastened into the compression chamber, where the

pressure of the explosive mixture can best be depended upon. This tube *a* may be of china, nickel or platinum, and the flame applied at a predetermined spot heats it to a dull red. The interior of the tube is filled with the burnt gases of the previous charge, but when the fresh charge is compressed it is forced gradually into the tube until it reaches the heated portion and ignition follows. Contrary to what might be expected ignition is not immediately communicated inwards to the charge, but the flame burns in the tube for an interval of time, dependent on the speed of the piston. As long as compression increases, the piston not having reached the end of the stroke, a continuous fresh supply of the charge is forced into the tube, this supply being faster than the combustion within the tube. It is only when the supply of combustible is less than its consumption that the flame eats its way out, and the apparatus can be so adjusted that ignition of the whole charge occurs at the moment of maximum compression.

When the piston moves slowly in starting the engine ignition may occur too soon. This is prevented by moving the heating jet further along the tube, away from the open end. As soon as the engine is running full speed the heating jet is moved towards the compression chamber, so that perfect regulation is easily possible.

This apparatus is at once ideally simple and wholly automatic, as long as the engine runs normally. It fails, however, if the engine slows down from overloading, for in this case ignition is premature, expansion takes place before the end of the piston stroke and the engine is stopped.

In large slow-speed engines the automatic action cannot be depended on, hence a shutter, which opens automatically shortly before maximum compression, is inserted between the charge and the tube.

The story of the evolution of the benzine engine is also that of the petroleum engine, for it was very soon discovered that any benzine engine operating with the ignition tube could at once be adapted to petroleum merely by heating the inlet through which the petroleum flows, thus vaporizing the liquid on its way to the combustion chamber. In petroleum as well as in benzine engines the all important mechanism is a well designed and reliable incandescent igniter.

Owing to its volatile properties it is possible also to use benzine in piston engines built on the same theory as steam engines. Benzine engines of this type are also known as naphtha motors. In these the benzine is vaporized in special boilers, and then the expansion of this benzine vapor is used in a manner wholly analogous to the expansion of water-vapor to drive a piston, with the only difference being that

the exhaust of benzine vapor from the cylinders is used as fuel under the boilers.

The utility of this type of benzine engine is very limited, and we shall not consider them further, but pass at once to those engines in which explosion within the cylinder furnishes the motive force. Of all the internal explosive fuels benzine is one of the best. There is no other combustible, not even illuminating gas, equal to it. If it were not so dangerous and inflammable before use it would be an ideal fuel, for being a liquid it can be easily carried through pipes by gravity, or pumped to the place where needed; it is cheap (and in Germany free from tax if used for engines), the present price being eleven pfennigs per kilo. at Bremen, or about eight cents a gallon. It is easily bought everywhere in the civilized world, burns when mixed with air in very greatly varying proportions without odor, smoke or residue. Benzine engines are simple in construction, and more reliable than either gas or petroleum engines, and for the same sizes are of greater power. The only objection to them lies in the danger of storage and use of the fuel. The danger of accidental explosions of benzine vapor has been minimized, one might even say eliminated, by the use of the electric spark ignition in the combustion chamber, yet benzine has such a bad reputation that fire insurance companies frown on its use and impose many vexatious, restrictive and expensive regulations, which add to its unpopularity.

For this reason very few benzine engines are in use in buildings, a much less restricted field having been found in open air power plants, such as threshing machines, pumping engines, boats propulsion, and more recently they have been very highly perfected for automobiles. A change, however, is beginning in Germany, for in the neighborhood of Bremen, the main depot for benzine, many owners of petroleum engines are remodelling them as benzine engines, owing to its greater cheapness and convenience.

The unimportant modifications of construction in different types are generally limited to the method of air and vapor mixture. In stationary engines benzine is forced into the combustion chamber in liquid form, but in the automobiles carburetters are used which saturate the air with benzine vapor, and this mixture is then used, benzine possessing to a high degree the property of vaporizing at normal temperatures, and remaining indefinitely suspended or diffused through the air as an explosive mixture. If the surrounding air is cooler than 55° F. (12° C.) the benzine must be heated, and to start the engine a benzine or alcohol lamp is required, but, after starting, the

exhaust gases supply more than sufficient heat. If care is observed to maintain the required minimum temperature it is almost impossible for any trouble to arise from insufficient mixture.

The benzine engines used in automobiles have usually but two valves, an inlet and exhaust, and are operated with automatic incandescent-tube or electric spark, the current being provided by an accumulator or magneto-electric battery. These engines are exceedingly simple, and can be built to weigh very little, the three-quarter horse-power engine of the de Dion and Bouton tricycle weighing less than fifty pounds (22 kilos.). In order to lessen weight benzine engines have been very recently constructed for automobiles on the double-acting principle. In these the piston receives an impulse every second stroke, the forward half of the cylinder acting as air pump, compressing the air slightly, storing and discharging it into the combustion chamber of the cylinder shortly before the end of the exhaust, thus clearing it of all burnt gases. Engines of this type are twice as powerful weight for weight as those built on the single-acting principle, or Otto cycle.

With the diminution of the weight of the engine on the one hand progress has also been made, on the other hand, in avoiding the weght due to the inconvenient and heavy cooling water and cylinder jacket, by using air cooling in its stead. The rapid speed with which automobiles travel facilitates the solution of this problem. The de Dion and Bouton tricycle already mentioned is provided with an air cooler. The cylinder is furnished with a number of very deep and thin steel flanges or ribs, which offer a very large extended cooling surface to the air. Although this engine makes more than a thousand revolutions per minute it remains cool, and the lubricating oil is not carbonized. In other engines the fly-wheel is so designed as to act as ventilator, drawing over the cylinder walls a volume of air sufficient to keep the temperature down.

Passing from benzine engines we come to petroleum engines, that is, engines using a liquid fuel not vaporizing at normal temperatures. The chief fuels of this sort are the commercial brands of illuminating petroleums and solar oil, which is distilled from lignites. With these there is much less danger of fire than with benzine, and the oils are much more generally obtainable. Owing to its extreme fluidity petroleum spreads very thinly over the metal walls, and when these are of cast iron it penetrates the pores beneath the surface, and when the latter is heated the oil is very rapidly converted into vapor. When hot petroleum vapor is mixed with cold air it becomes at once a sus-

pended vapor like a fog, which when mixed with more air becomes an explosive compound, marked by a remarkably low temperature of ignition. Usually the term "ignition temperature" implies dull red heat (for illuminating gas, bright red heat), but mixtures of petroleum and air ignite at temperatures between 480° and 570° F. (250° to 300° C.). This property of petroleum vapor is very advantageous, and renders a petroleum engine more manageable than either a gas or benzine engine, but the great drawback is that mixtures of petroleum vapor and air in an internal combustion engine are not fully burnt. The exhaust is always visible as smoke, smells abominably, and will smut a sheet of white paper with spots of unburned oil. Benzine engines are first heard and then smelled, but petroleum engines offend the nostrils long before they can be heard. If noxious odors are liable to become a public nuisance petroleum engines should not be installed. This decision does not apply with the same force to open air use, and in farming operations this form of engine has very extended utility and advantages.

The danger of fire is much less with petroleum than with benzine, and with any kind of prudent care these motors are as safe as gas engines. Notwithstanding the incomplete combustion (a very small percentage of unconsumed hydro-carbons will make dense smoke and evil smell, as when the common petroleum lamp smokes), the petroleum engine costs in fuel very little more than the same powered gas and benzine engines. The normal fuel consumption is from 400 to 500 grams of oil per horse-power hour, or one gallon of oil per horse-power for six to eight hours, or in round numbers a pound of combustible per horse power, the equivalent of a pound and a half of coal.

The reason of the incomplete combustion compared to gas and benzine vapor is that both the latter diffuse in air very rapidly and completely, so that both form a perfectly uniform explosive; but with petroleum the conditions are very different. When mixed with cold air the small globules of oil form indeed a petroleum fog, but there is no molecular diffusion, and unless the air is well stirred it is hard to obtain a condition approaching mechanical diffusion, except very slowly. Distinct cloud patches of unburnt petroleum fog float off through the air in the exhaust puffs, and it is these clouds which carry the objectionable smell to a very great distance. If petroleum fog comes in contact with a cool solid it immediately condenses and shows the characteristic fluidity, an attentuated filminess. The cooled cylinder walls of the petroleum engine being colder than the minimum temperature for complete vaporizing, 480° F., a part of the fog is

condensed when the charge is drawn in, and during the succeeding explosion stroke the oil is again vaporized, but not burnt owing to lack of oxygen, and escapes as a loss with the exhaust.

Attempts to burn all the oil by some other method than premixture with air are fully justified, and it is the type of internal combustion as distinguished from the explosion motor that gives the most promise for the future.

THE DIESEL MOTOR.

In the sketch of the evolution of the gas engine internal combustion engines were mentioned. The difference between the two types, internal combustion and explosion, is fundamentally that in combustion the air is not pre-mixed with the fuel to form an explosive, but is admitted only during combustion.

The Diesel motor, named after the inventor, Mr. Rudolph Diesel, of Munich, is of this type, and he seems to have solved successfully the problem of a practical internal combustion engine. The next few years will show the real merits of this engine, and whether it can be built in indefinitely large sizes, although already large powers are obtained by coupling several engines. In the Diesel motor the atomized oil is sprayed into the previously compressed charge of air. Each globule of oil finds itself surrounded by the requisite oxygen for complete combustion, heated to the ignition point by previous compression. Absolute and complete combustion must follow if the oil has been sufficiently sprayed through the combustion chamber, in this case the cylinder. An excess of air does not interfere with combustion, and the automatically regulated quantity of oil to furnish the power required is fully consumed. In the latest trials it is claimed that this motor under full load consumed but 210 grams of oil per horse-power hour, as against a minimum of 400 grams in the explosive engines. When running under partial load fuel consumption is insignificantly greater in proportion, and this is one of the chief merits of this engine. There is also neither smoke, deposit or smell. It not only operates with half the fuel consumption but obviates the more serious objections to earlier types of petroleum engines, namely, the dirt and objectionable smell.

The illustration shows a Diesel motor, built by the Maschinenbau-Actien-Gesellschaft of Nuremberg, and exhibited at the Munich Exposition.

More recently Donát Bánki, of Budapest, has used very high compression in an explosion oil engine. His method is an injection of atomized petroleum and of atomized water. The water absorbs so much of the heat generated by compression that the ignition temperature is not reached. The danger of premature explosion is thus prevented, and the consumption of fuel is said to be remarkably low.

With these inventions of Diesel and Bánki petroleum engines are giving promise of very successful evolution, and time will show whether piston engines with initial pressures of 30 to 35 atmospheres have durability justifying commercial use. If they can be built in large sizes a brilliant future is before them. One has but to think of

their use in war and in merchant vessels, where they offer such great advantages in the instantaneous start, in the elimination of boiler weight and space, of coal bunkers, of the army of stokers and coal passers. Dangerous steam pipes can be dispensed with; there will be no funnel, for there will be no smoke, no ashes and no clinkers. Engine and furnace holds would cease to be comparable to the infernal regions, but become abodes of comfort if not of delight. The oil tanks could be located in out-of-the-way places, without taking up valuable cargo room. The fuel would flow with natural or artificial pressure to the engines. All the auxiliary engines of modern ships, used to drive the dynamos, the ventilators, the donkey engines, steam steering gear, steam capstans, cranes, etc., which consume such a large proportion of the steam, besides necessitating long and dangerous steam pipes and complicated boiler installation—all these can be advantageously replaced by petroleum engines. Everywhere, if the supply of fuel is sufficiently abundant and cheap, petroleum motors can take the place of steam engines. Coal is found very widely distributed and in abundance, while petroleum is as yet limited in supply, but it is probable that increased demand for oil will lead to increased artificial supply of liquid fuels suitable for power production.

The subject of further evolution of benzine and petroleum engines cannot be dismissed without brief consideration of the rivalry of electric motors.

Those who have followed the growth of electric science during the last twenty years, who have personally experienced the convenience of electric installations, must admit that no known form of small power engine can compete with them. There are other considerations than those of mere cheapness of fuel, in which benzine, gas and oil engines are superior. The electric motor can scarcely be called an engine—certainly not a heat engine, with its ever annoying leaky valves or pistons, for the electric motor is nothing but a transmission link, causing no worry, stopping or starting, accelerating of slowing, at the touch of a lever.

But because the electric motors occupy a field from which they cannot be driven, because there is an ever-increasing demand for them, there must also be an ever growing demand for heat engines to produce the electric current for these electric motors, and these heat engines must be ever larger and larger, more economical and convenient in operation This demand will inevitably be filled by internal combustion engines of the explosive and combustion types.

SHORT DISTANCE ELECTRIC POWER DISTRIBUTION.

By James Swinburne.

A GENERAL introduction to the subject is all I am asked to give, so I shall attempt to touch the various branches lightly, leaving the more detailed and technical examination of the twigs to others.

Long distance transmission, especially in connection with water power and high pressures, has attracted the attention of the electrical engineer so strongly that he has not given as much thought to the apparently smaller and less important matter of local distribution of power as the subject perhaps deserves. This is to some extent because the equipment of workshops makes little noise. In such cases electric driving is generally carried out quietly by the engineers who have charge of the works, and the consulting engineer is not called in, and there is no Institution paper read anywhere, and nothing exciting happens: the machinery is merely put in and set to work. This is a great drawback; not because Institution papers are specially good things, or because consulting engineers ought specially to be encouraged, though personally of course I think they ought, but because it allows the subject to fall into the background in a way which is not warranted by its importance. The result is that most workshop engineers—I very nearly said mill-wrights, forgetting that the race is extinct now—know nothing about electrical motors, and never think of them in designing a shop. It is not that electric driving is not good enough; it is that it is never considered at all in many cases.

The most obvious places for electric motors are those in which there is a difficulty with any other method of transmission. Mining, especially coal mining, occurs at once as a good example. Higher efficiency, cheapness, safety, and practicability of the electric motor put it in the front rank at once.

The next case is where scattered steam engines are employed. Take the case of the average chemical works, for instance, or iron yard. You find a pipe supported on infrequent poles, giving a sort of cross country excursion, every day. You know it is meant to be a steam pipe because there is warm water leaking from all the joints, and that it is not lagged because it was considered that enough internal

warmth would get along the inside to prevent freezing. If you trace this pipe out, you will find it goes to a punching bear or shears, which are rattled around by a steam and warm water engine which leaks too much for the water to blow its cylinder ends off. The amount of money wasted in this way is something terrible.

In connection with docks, yards, wharves and so on, where there are many cranes, hydraulic power distribution is generally employed. Hydraulic distribution has a great advantage when the work to be done consists of moving something a short distance against a great force, as in the case of pressing, rivetting, and pressing and drawing; but in the case of lifting, the electrical system is generally more convenient. The majority of cranes in Great Britain are probably worked by local steam engines of the worst and most inefficient kind. Of course, where there are no facilities for anything like a central generating station, the electrical system is infinitely better than this, but compared with hydraulics the advantages are not so marked. One great drawback of the hydraulic system is the inefficiency. The ram has always enough pressure behind it to do the maximum work it will ever be called upon to do, and it uses a corresponding amount of energy every stroke, whether it really has any work to do or not. This extra energy goes into the water, and the inefficiency of the hydraulic system is easily gathered from the temperature of its water. As already remarked, the hydraulic system is best for slow thrusts, but when the mechanism involves gearing up, the electric motor naturally comes in even if it has to gear down. It is more efficient to gear down than up. A hydraulic capstan, for instance, is a monstrosity.

So far we have dealt with cases in which neglect of electrical transmission is a crime. We will now pass to a larger class, in which it is merely a prevalent vice. The electrical system may be compared with its competitors in order.

The motor may replace the local steam engine and boiler. That means generating on a larger and therefore more economical scale, with smaller coal and oil bills, and less labour. If the local engines to be replaced have varying loads, great economy may result, because the larger engine by averaging the load may work at an economical load always, and its maximum power may be very much less than the aggregate power of the smaller engines. The motor has a very much higher efficiency under varying loads than the engine, so there is a fair source of economy. Unless the local engines are very large, motors can replace them with great advantage in nearly all cases. As a special instance, we may take the average iron works. Here there

are large engines, generally with local boilers dotted about, each engine working one rolling mill. In the case of an ordinary engineering works, each shop has generally its own engine and boiler, involving access for coal, special labour and low economy. Going back to the iron or steel works, there is general need for some local generating plant such as the blowing engines, which work on steady and therefore economical load; and there is no reason why a power house should not be arranged at that spot for the supply of the whole system.

The next arrangement is the common vice of having a boiler which supplies one engine close to it, and feeds a distribution system of steam piping, generally very badly lagged, which supplies small engines dotted about for running saws, cranes, or large machine tools. In such cases the motor saves an enormous waste in the steam pipes, and attention is very much more economical as regards power.

The gas engine is a lively competitor of the motor when the power is supplied by a central station. If gas costs, say two shillings per thousand cubic feet, and electric energy fourpence, the cost of electrical energy comes out about six times that of gas. The difference is so great that in many cases the gas engine is better than the electric motor, though it has a varying load and takes nearly the full amount of gas always, and though it needs more attention and costs more to begin with. The real reason is that the price paid for electrical energy from the central station is enormously high, on account of the capital sunk in mains, motors and expensive sites, and on account of the expense of running and collection. In cases where the power is supplied by the consumer himself it comes out so much cheaper that gas power cannot compete with it at all.

Motor driving from public central stations is hardly developed yet. Several attempts have been made to put down large distribution systems which could supply comparatively small consumers with power at rates much lower than they could reach themselves; but the corporations always object, as they would rather generate electrical power themselves expensively than allow others to supply the public cheaply. It is probable there will soon be a swing of the pendulum in the other direction, and the rampart socialism that is prevalent will give place to better conditions. I do not exactly know what rampant or any other kind of socialism is, though I have read a good deal in order to find out. As far as I can gather, socialism consists chiefly in dissatisfaction with all possible economic conditions, coupled with an ardent desire to benefit everybody, especially the incompetent and idle, at the expense either of the capitalist if the socialist is vicious, or

of nobody in particular if he is really philanthropic. Socialism is a vague disease like general paralysis; but its chief symptom is not mere ignorance, but a negative knowledge of economics. Hence it seems rational to class municipalisation as a form of socialism. Of course municipalisation is also mixed up in some way with the labour vote, and progressivism, and trade unionism, are the chief symptoms of this variety of the disease. Coming back from isms to common sense and motors, the great development of the electrical motor will be in taking the place of the ordinary belt and shafting transmission in all kinds of factories. In such cases, for instance, as flour milling, where the machines run at constant speed and approximately constant load, the opening for electric transmission is perhaps smallest, but even in that case it will probably pay. This example is taken as perhaps the worst of its kind for electrical transmission, and even here the motor has some great advantages which may make it worth while to put in electric transmission in case of new mills even if it does not pay to change existing plant. In the first place, all the shafting and belting is taken away and lighter buildings are necessary. Smooth working and silent running is obtained, and the efficiency is certainly increased, that is to say, smaller engine power is needed.

In the case of cotton spinning, the same reasoning applies. The electric motor has here a very special advantage. A properly designed shunt machine runs at constant speed not only with varying load, but also under varying pressure, so that the machinery can run at constant speed even though the driving engine varies considerably.

The driving of machine tools by motors has perhaps received more attention than all the other applications of small motors put together. As a rule engineers arrange their own shops in a way which they would be ashamed to adopt in filling an order. There is no doubt that all tools can be best driven by motors, the only question that is open is, whether each tool should have its own motor, or whether several small tools, such as lathes, shall have a shaft and one motor for the lot. The only other question of difficulty is to choose between direct current and the polyphase system. The absence of all noise from a shop is in itself by no means a particularly sentimental consideration; the disappearance of all overhead shafting has thus an advantage apart from the fitness for overhead cranes, and even small overhead runners. The small motor is, however, much less efficient than frequently supposed. There is a common idea that all dynamos and motors run up to high efficiencies, say 95 per cent. or so, but small motors are much more likely to be of the order of 59 per cent. The

initial expense of small motors is their chief attribute, however, and in addition to this, machine tools are not designed for motors to begin with, but the maker sticks it on where he can under protest, and treats it as an architect does a church organ, as an unavoidable evil, which has to be tolerated, but must not be considered. A great part of the cost of the small motor is the frame work and bearings, and if the machine tool were properly designed, and the motor made by the tool maker, this cost would be saved, for the motor and frame would take the place of the bearings and framework of other motion or reduction gear employed in connection with belt driving. At present the motor is bought as a complete mechanism from some electrical works.

Next as to varying speeds. As automatic tools come into more general use, the need for wide variations of speed become unnecessary. But in most cases variations of speed are required, and the old pulleys are kept in the machine. Probably the simplest method of getting various speeds in direct current systems is by having several mains. Thus, a four wire system having 30, 60, and 120 volts gives speed ratios of 1, 2, 3, 4, 6, and 7, which is much more than most speed pulleys. The field magnets are always fully excited by the 210 volts across the outers, and the armature takes the various pressures. This system gives good economy and is simple, and it costs little extra to run four wires instead of two. The question of speed is not so easily dealt with in the case of polyphase machines, as it is necessary there to have several sets of mains with different frequencies as well as different pressures, or to have more or less complicated methods of coupling the inducing element.

One of the greatest, and perhaps the least recognised advantages of electrical driving without shafting is that as each machine is self-contained, the ordinary foundations can be left out. A lathe or any other tool if decently designed, does not depend on the foundations for rigidity; the only thing the foundations do is to take up the shake communicated from outside by the belts. A self contained machine runs better the less it is fastened down, or to take Mr. Beaumont's motto, "If the mechanism wants to wobble, let it wobble." The stresses on all the parts, for instance, of a badly balanced mechanism are less if the framework is not fixed to any foundations. The saving of foundations and belting as well as shafting should be credited to the motor, and the saving in wear and tear of the belting, as well as in mere coal and oil, should also be credited to the motor's running account.

In all sorts of portable tools, such as drilling, rivetting, power

chipping, power caulking, countersinking, and tapping, the motor is far away ahead of compressed air, steam, rotating spirals or any other systems; and there is no reason why portable riveters and punches should not be driven electrically too.

On board ship, there is a large opportunity for the introduction of electric control of steering gear, capstans, winches, pumps, and all sorts of discharging gear. In men-of-war electricity is also applicable for working the guns, turrets, loading gear, and similar mechanisms. One obvious advantage is that the transmission system, namely, the mains, can be very easily arranged in duplicate, so that a shot is not so likely to cause disablement.

EDITORIAL COMMENT

The Conferences of the Institution of Civil Engineers, and the excursions in connection with them, abundantly illustrated the wide range of the profession in Great Britain, where differentiation has not gone so far as an attempt to make half a dozen kinds of engineering, each distinct and all co-equal. The idea still obtains that all engineering which is not "military" is "civil"; with the enormous increase in the perfection and the use of mechanical appliances, all modern engineering is certainly mechanical; and it meets but a slight hyperbole to say that now-a-days it is all electrical. Any further classification is of province or purpose—not of practice. The range is now so wide that it is expedient to specialise in work, as it is convenient to classify engineering literature, under many departments; but all parts are so interdependent that it is well to keep the common bond and the common meeting ground.

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Those who were fortunate enough to accompany the Institution on the visit to Crewe had an opportunity to study a works typical of the comprehensive British practice, in antithesis to the specialising American practice which is now so much under discussion. The one aims at covering as many as possible of the stages of manufacture which separate the raw material from the finished machine; the other seeks subdivision of processes, distribution of operations, and concentration upon as few as possible in any one establishment. The one strives for economy by collecting into the one treasury the profits of the largest practicable number of industrial operations contributing to the finished work; the other is directed to the effort to cheapen production by collecting into the one works the largest practicable volume of work of specialised character, and lowering the cost of that by standardising, by the use of special machinery, and by intensified production.

Thus the Crewe works really display almost every operation connected with the production of railway material and supplies —for equipment, line, signal systems, or buildings—reaching as far back even as the Bessemer converter and the open hearth furnace. The typical American railway shops, on the other hand, are essentially for repairs and maintenance of equipment, with enough new building of locomotives or coaches only to furnish stability in working. Possibly it would be fair to estimate that the largest American roads do not build more than one-third of their engines in their own shops, and never dream of any other course than buying rails, boiler plate, steel bars, structural shapes, or signal apparatus from outside establishments.

We may safely leave our contributors to discuss the two systems from the standpoint of their respective claims to the maintenance of stability and the furtherance of economy. It is of interest, however, to point out that the British policy, while apparently making the railways very independent up to a certain point, leaves them curiously helpless when the demand for engines exceeds their own building capacity; for they have not, by steady support, built up a strong outside locomotive-building industry such as that which has been developed under the American policy and has enabled the United States to enter markets where their competition was least expected.

* * *

In the debate upon the respective merits of British, Continental and American machine shop practice generalisation as to the national characteristics displayed either by workmen or managers, must be qualified by the recollection that there has been a free interchange between the great industrial nations during recent years. Many Americans may be found in German works; conversely, many English, Scotch, German and Swedish foremen and managers are directing American engineering establishments. The Clyde and the Tyne have been drawn upon for the personnel of foreign yards, and marine and mechanical triumphs

accomplished under other flags might often trace their heritage to British ancestry. The greatest study for Great Britain to-day is the industrial policy which will give the fullest play and the largest reward to her industrial talent at home. She must not be slower than her rivals to incorporate into her own system the best that can be found anywhere, either in engineering practice or in industrial policy.

It is the aim and the constant effort of THE ENGINEERING MAGAZINE to further industrial advance by setting forth the work and the thought of authorities and critics of the highest standing and the widest international experience.

* * *

An American paper, commenting upon the introduction of American engines upon British railways, rejoices especially over the value they will have to the English public as models of higher æsthetics in locomotive building.

There will be more than one opinion on this point. Aesthetics, hardly less than theology, have always been the domain of absolute dogmatism—and yet there is hardly any field in which the accustomed is more likely to be confused with the absolute. But it would hardly do to say there is no absolute standard of beauty in machinery, and it would be interesting to know how many years of custom it would take to reconcile one to the lines of some of the Continental engines. Take, for example, those Belgian locomotives with a square smokestack, and behind it a series of protuberances on the boiler, gradually diminishing in size as one proceeds toward the foot plate, giving the general effect of a giraffe equipped with the running gear of a dachshund—surely, though they may be very useful, even their makers can hardly believe them to be beautiful.

The American designer has not been so closely limited as the British designer has, either in height or breadth. With more generous proportions, he has kept his lines simpler and made his machine heavier, following the tendency which is even more strongly manifested in the American railway carriages. One of the greatest English engine builders recently deplored the appearance of the same movement in Great Britain. It seems inseparable from the demands of the traffic department for more luxurious carriages, higher speeds and longer runs. The more credit to British locomotive designers that they have met every such demand, while working always within the narrow limits fixed by existing height of tunnels and widths between platforms.

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It is proverbially unsafe to assume that that which follows is necessarily consequent upon that which precedes. Without further study, therefore, it will not quite do to assume that the recent heavy decline in American exports is a result of the trust-forming mania which has raged in the United States for some time past. It has, however, been pointed out frequently in these columns that a loss of foreign trade to the United States was reasonably to be expected as a result of some of the "combines"—such, particularly, as could have no object but the maintenance of high selling prices.

That the immediate decline of American sales is probably, in part at least, an effect of the trust-disease is suggested by a recent paragraph, stating that a British firm had obtained an order for 300 tons of guard rails for the Boston, U. S. A., overhead railway, and that the fish plates were to be supplied by another British maker, both orders having been placed in England, to the buyers' considerable advantage, because American manufacturers had combined to keep up prices and had overdone the thing.

Until the United States settles the industrial system upon the broad and stable basis of a sound political economy, American manufacturers will struggle against heavy disadvantages in the markets of the world.

* * *

Affairs in South Africa furnish another instance of the fact—often referred to in these pages—that politics, and especially international politics, are becoming of more and more importance to the engineer, because they are more and more based upon industrial and economic questions of vital concern to his work.

In the case of the Transvaal the political phase has been so largely developed of late that the real issue is in danger of being hid-

den. It is most gratifying to be able to secure so high an authority as Dr. Hatch to restate the propositions upon which the whole matter depends. It is not the oppression of a small power by a great one, but the oppression, by an obstinate and dull sighted government, of an industry which, by the nature of the case, is wholly in its power. Boer apologists assert that the Republic did not care to have the mines opened—they merely permitted the working under conditions which were accepted, and should not now be disputed by the miners.

As a matter of fact, the conditions have been changed repeatedly to the disadvantage of the industry. The Boer government has shown a settled determination to allow nothing to limit its greed in extorting the last penny which can be wrung from the mines; and its eagerness to receive and expend the revenue they bring in fits ill with its protestations of longing for the pastoral peace—and bankruptcy—which existed before the reefs were worked.

The "weaker power" is the mining industry, striving manfully to help itself so far as good practice can go. The interest of the engineering and economic world demands that good government and a liberal industrial policy be brought to supplement the miners' own efforts.

Dr. Hatch speaks the dispassionate opinion of the mining and geological expert. He has not been identified with the political agitation in the Transvaal, and his conclusions have no tinge of the bitterness which might cling to the disappointed reformer. But they carry the authority of his thorough study and his intimate and immediate knowledge of the natural and economic condition of the field.

* * *

The water-tube boiler is certainly taking a place among the living and striving growths of modern engineering when a London evening daily opens its columns to a discussion of the pros and cons. The strong popular interest in the navy may warrant a departure which seems extreme for daily journalism—although industrial topics are gradually taking a larger and larger place in the lighter forms, even, of current literature. It is doubtful, however, if this particular discussion is going to introduce into the argument anything except a flavour of extreme bitterness. The case is not being tried by proper advocates nor in a competent court; the proceedings are irregular and the verdict, if any be reached, will have no force.

Probably a fair statement at present is that the many and great advantages of the type have stimulated many attempts to solve the problem of design, most of which lack entire completeness, or miss entire perfection, in some one point. Marine service—the severest, probably, which can be conceived—demonstrates the defect far more conspicuously than the excellence. The demonstration is made in a glare of publicity to begin with. The opponents of each type add the searchlight of investigating criticism and proclaim their condemnation with the bell of the town crier.

Meantime the designers, profiting more from the failure than from the success, are going steadily on to remove the defective details and to increase the general excellence. Some types, at least, have demonstrated their high economy and efficiency throughout a remarkable range of duty-requirements. For many classes of service, the water-tube boiler is admitted to be the only acceptable type; its adaptation to larger units and its introduction to the merchant marine may be regarded as certainties in the very near future.

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In the entertaining account of the construction of the various routes to the Klondike gold fields given by Mr. Harrington Emerson in another place in this issue, the construction of the White Pass and Yukon Railway is described as completed to the summit of the White Pass. From that point to the waters of the Yukon the journey affords no insuperable obstacles, and hence railway traffic at once began when the summit was reached. Since Mr. Emerson left Alaska, however, work upon the railway has been steadily continued, and on July 6, 1899, rail communication was opened as far as Lake Bennett. Although the road is to be continued to Fort Selkirk, yet the continuous railway from Dyea to Lake Bennett practically opens up the whole of the Klondike country to the rest of the world, and removes all hardship as far as travel is concerned. The passenger

from Seattle or Vancouver can now proceed by boat to Dyea, where he takes the train over the White Pass to Lake Bennett, and from thence proceeds by boat down the Yukon to Dawson without difficulty or delay. The natural result will be a transformation similar to that which has taken place in other mining regions so soon as transportation facilities have been provided. Where there is gold to come out the products of civilized life will flow in. Labor conditions will become equalized, scientific and technical methods of work will be adopted, and mining in Alaska will become what it has become in other parts of the world, a legitimate business instead of a gambling hazard.

* * *

It is rather interesting to note the contest which is incessantly being waged between land and water transport in every part of the world. One does not have to turn to the American isthmus to find evidence of this. When bodies of water divide countries (or, as has been better said, when they unite them), plans are made without number for bridges to span them or tunnels to bore under them, as witness the proposed tunnels between France and England, between England and Ireland, and between Spain and Africa.

A noteworthy example of the reverse is seen in the contest between land and water transport in Southern Europe, as reviewed at length elsewhere. When the Alps maintained their rocky barrier between Italy and the rest of Europe, trade naturally and freely flowed around by way of the sea. Since the mountains have been pierced, and rapid land transport established, every energy on the part of the people and places interested in the older line of trade has been exerted to regain the lost pre-eminence and combat successfully the overland routes.

It is but natural that local interests should struggle for self-preservation, but there can be little doubt that there is room for both systems in many places, although not to the prejudiced eyes of interested persons. For this reason it appears to the distant outside observer as if each branch of commerce should be distinctly judged upon its merits apart from purely local considerations, the work of the engineer being called upon to build up the natural advantages of one locality without designedly destroying those of another.

REVIEW OF THE BRITISH PRESS

The Conference of the Institution of Civil Engineers.

THE Second Biennial Conference of the Institution of Civil Engineers produced such a wealth of papers upon all branches of engineering that it is impossible to review them at length, and the interested reader must be referred to the columns of both *The Engineer* and *Engineering*, in which the transactions are most fully recorded. At the same time, a review of the conference as a whole may be given here, at least as a tribute to a most noteworthy gathering, and possibly also as an indication of the general trend of the proceedings and of the work which was done.

Two things especially are to be noted about the conference, one being the subdivision of the work among sections devoted to distinct branches of engineering; the other being the condensed brevity of the papers, by which a great amount of valuable matter was presented in a form best adapted to the occasion. The idea of subdivision into sections is not new, but it is certainly good. Both the British and the American Associations for the Advancement of Science have found it advisable to divide the work in order that it may be more successfully attacked, and the same plan has been adopted at the professional congresses which have been held at the various international exhibitions. The condensation of the papers proved advantageous or otherwise according to the facility possessed by the author in so treating his work, but in the main the result was satisfactory.

The subdivision of the work of the conference was into seven sections, as follows: I., Railways; II., Harbours, Docks, and Canals; III., Machinery; IV., Mining and Metallurgy; V., Shipbuilding; VI., Waterworks, Sewerage, and Gas Works; VII., Application of Electricity.

Taking up very briefly the work of these several sections in order, the papers before the first section dealt mainly with two subjects; special railways for light service or mountain traffic, and methods of railway signalling. In the first subject the most important point brought out was the importance of adhering to the standard gauge for all purposes, there being little or no economy in narrow gauge; while in connection with the second subject it was shown to be most desirable that railways which used any portion of road in common should use the same systems of signalling, as otherwise confusion might be expected. Papers upon earth-slips, upon handling and transport of minerals, and upon relaying railway track were also presented.

In the second section some important papers were read, notably one upon the discharge and reloading of steamers, and one upon grading docks. The great increase in the size and capacity of steamers is causing correspondingly increased demands to be made both upon the dimensions of docks and and the capacity of handling machinery, while the limitations of the depth of water over the bar in important harbors makes a limit to the draught of vessels which can only be extended by important harbor improvements.

A portion of the papers in the third section related to railway work in its department of motive power, compound locomotives for main line service, and various motors for light railways and for automobiles both being discussed. In machine work proper we may note papers upon English machine tools as compared with American and German practice, as well as those upon the best motive power for use with cranes. Papers upon condensing plants and upon forging machinery were also presented.

In mining and metallurgy the attention was divided between steel making and coal and gold mining. Some valuable tables of color temperatures and of melting points as determined by the Le Chatelier pyrometer, were given by Mr. Hadfield, and interesting information about problems and methods in the Transvaal by Mr. Irvine.

The fifth section, devoted to shipbuilding,

contained several papers which bore upon the discussions upon harbors and docks, the increasing size of vessels being a fertile theme. The question of the use of merchant vessels as auxiliary cruisers was also brought up, doubtless stimulated by the experiences of the Spanish-American war.

Among the papers in the sixth section, which may be considered as relating practically to problems in municipal engineering, the most important related to sewage disposal and to water supply. In the latter subject the question of waste of water received especial consideration, and indeed this bids fair to become an important municipal problem everywhere.

In the electrical section the mechanical side of electrical engineering received the greater share of attention, long distance transmission, as well as transformation, being discussed, to which also the subject of mechanical traction by electricity and the construction of electric meters formed excellent adjuncts. Judging from the importance of the subjects presented to the various sections and the professional eminence of the authors, the conference was an undoubted success, and a close perusal of the papers shows the great value of the varied mass of information thus gathered.

It is an unfortunate consequence, however, of the attempt to combine technical discussions with excursions and social entertainments, that the discussions are sure to suffer. Papers such as those to which reference has been made should have elicited such discussions from the audiences to which they were presented as would have added much to the value of the information contained in them. In very many cases, on the contrary, the discussions were cut short because the time for some excursion was pressing close, and the debate suffered accordingly. This great loss might well have been avoided by the presentation of written discussions by title, supplemented by written comments added after the conference, the text of the original papers being placed in the hands of all members in advance. Even with this drawback the conference of 1899 will be remembered as a most important professional and social gathering, while the record, in the form of the many valuable papers, will mark the contribution to applied science.

Science and Engineering.

In his opening address before the Conference of the Institution of Civil Engineers the president, Sir W. H. Preece, made some very apt remarks about the relation of science to practice within the realm of engineering. Many years ago Lord Brougham defined science as "Knowledge reduced to a system," and in this definition Sir W. H. Preece followed him very closely.

"Science, a much abused term, is the systematised collection of the facts and laws of nature, and engineering is their practical application to the use and convenience of man. There is a great tendency to put the cart before the horse. Science has followed, it has not led engineering. It is their intimate association which is the foundation of all industrial progress. The war of the microbes, the latest development of biology, is a consequence of sanitary requirements. Our knowledge of the diffusion of molecules and the solution of solids has sprung from the investigation into the mechanical properties and constitution of iron and its alloys; and the disturbances of the ether are becoming familiar through the practice of the so-called wireless telegraphy. Facts are derived from accident, observation or practice; laws are the result of research. Engineers have always appreciated science up to the hilt, but they wish that its special votaries were less dogmatic and more modest."

Some good points were made in the address concerning the possibility of rightly conferring degrees in engineering. This practice, followed by some educational institutions, has always been deprecated by the Council of the Institution of Civil Engineers. "Every engineer must acquire a knowledge of the scientific principles and the mental tools that form the bases and aid the operations of his profession, but he can become an engineer only by becoming an expert in its practice."

The truth of this position will be admitted by every practicing engineer, and there are few indeed who will maintain that a knowledge of the profession of engineering can be attained without the hard training which comes only by practical experience. Beneath this, however, must be laid the broad foundation of sound knowledge of fundamental principles, a knowledge so thorough-

ly ingrained as to become almost intuitive, and which may be depended upon to reveal any fallacy which may be concealed beneath a plausible exterior.

It is the combination between science and practice which makes the truly successful engineer, and in developing such a combination organisations like the Institution of Civil Engineers are most efficient instruments. It avails but little for the purely theoretical man to develop some subject in defiance of the conditions which obtain in actual practice when he sees before him as he reads his paper men who know of their own hard experience wherein the fatal weaknesses of his treatment lie, while on the contrary, no man dare sustain a position contrary to the admitted laws of nature before those who can see through such fallacies at a glance.

Successful engineering is always composed of the intelligent union of science and practice, and the scientific man who knows how to be practical, and the practical man who is willing to be scientific, can meet on common ground in the broad field of engineering.

English and American Workmen.

In the course of some interesting comments on the different manner in which English and American workmen regard the introduction of labour-saving machinery, *The Engineer* shows that the only true solution of the problem of the congested state of English machine works lies in doing the very thing which the men are unwilling to permit. "The solution of the difficulty obviously lies in augmenting our production. We must build three locomotives where we now build two, and so on; but this can only be done by augmenting the productive power of the workmen. We cannot put on three men where there are now two; machinery must come to our aid."

Reference was made to a machine-riveting plant used in the United States, which saved 50 per cent. in labour, thus enabling one man to do the work of two. If such a plant were put in use in Great Britain the probabilities are that the men would refuse to have it.

"Such a policy will, of course, in the long run be suicidal; and, in any case, the machinery will take its place in our shipyards on its merits, just as all other machinery—such as the power loom and the boot-making machines—come to stay. But the question which presents itself as most pressing at this moment is not the future of any machine, or system of construction, but why should the working engineer in the United States be so different from the working engineer in this country?"

There is no doubt that the difference does exist, not only between the English and the American workman, but also between the English workman transplanted to America and his brother who has remained at home. It cannot, therefore, be a question of race; it must be a question of environment. In the United States the present and future surroundings of the capable machinist have much to do with the marked individuality which he possesses, or soon acquires. He has no idea of always remaining a machinist; on the contrary, he aspires to become a foreman, superintendent, manager, or even proprietor. As a result he takes an interest in his work, not merely for the direct value of the wages he is to receive, but also because he sees a future ahead of him which will lead to better things if he is capable of grasping them.

As a well-known American writer, himself an example of the truth of his own words, once wrote: "The comforts of life and home are within the reach of all American workingmen. The best of all things that are printed, the finest efforts of the stage, and the best of home comforts the American workman may enjoy. There is no social bar whatever to his political distinction. He may choose whether he will frequent the finest homes in the land or the lowest pot houses. Every prospect for the future which this wide world holds out for its choicest people the land holds out for the capable mechanic. Yet the shiftless, ignorant, thoughtless sluggard sees no show for the workingman. There is a show, *all* the show, but maybe none for him. The sensible mechanic don't gauge his own accomplishments by the contemptible lack of effort of the ignorant howler."

When a workman really begins to feel his individuality, and realises that he is not merely a member of a class, he also feels that his opportunity to rise must be made by his own efforts, and that so far from ex-

tra effort acting to reduce his opportunity for employment it really aids him to obtain a better and higher position. He is therefore quite willing to welcome the advent of labour-saving machinery, understanding that it is often labour-making machinery as well, and that while it may diminish the demand for labour of some kinds, it will increase it for that of other and higher kinds, much of which will fall to his share if he show himself worthy.

It is this opportunity for individual development which produces the independence of the workman in America, whatever be his origin, and in such an atmosphere the trade restrictions of unions and organisations fail to hold and control the best and ablest men. Labour unions there are, with arbitrary rules and extensive membership, but the most skillful machinists know that they can prosper far better by their individual efforts than by any such organisations, and it is largely if not altogether to this fact that the difference between the machinist in the United States and in Europe is due.

Separate Condensing Plants.

THE progress in various details of steam engineering is not always as rapid as some would have us believe, and it is curious to note how sometimes ideas which should be most obvious are not perceived until after many years.

The great impetus given to the development of the steam engine by Watt was mainly due to his invention of the separate condenser, which converted the wasteful engine of Newcomen into a serviceable and economical machine, but although subsequent builders soon added to the vacuum of the condenser the higher steam pressures which improved boilers made possible, Watt himself never encouraged the use of high-pressure steam but always preferred to depend principally upon the vacuum produced in the separate condenser for the power produced in his steam engines.

Until very recently the apparently obvious idea of extending the separate condenser idea to include the discharge of several engines into a single "central" condenser does not appear to have occurred to anyone, but during the past few years this extension of Watt's original invention has been made with decided success, and a number of such central condensing plants have been installed, especially in Germany.

This subject was discussed at the recent Conference of the Institution of Civil Engineers in a paper presented by Sir Alfred Searle Hasiam, in which the advantages obtained by the use of a central condensing plant were fully set forth.

"The older system adopted was the application of a condenser to each separate large engine, leaving the medium and small size engines without condensers, but in many modern installations, where a large number of various size engines are used in connection with the works, or more particularly in electric light stations, it is found advisable to have one large condenser to receive the steam from the various engines which may be distributed over the works or installations. In cases where this arrangement is not carried out, a large number of engines are frequently left unprovided with a condenser, the result being increased working expenses in coal consumption. A large condenser tends to economy and efficiency, also a reduction in first cost and economy in maintenance. Very careful tests have been made at factories where engines have been worked without condensers, and by the application of a condenser common to a large number of engines, an economy has been secured amounting to 20 per cent. or 30 per cent. of the coal consumption.

"On board ship these condensers are found to be of immense value. The old practice was to convey steam to the condenser of the main engines, but when the steamer is in port and the main engines are not at work, the auxiliary engines for electric light, refrigerating machinery, winches, cranes, and various engines used on board ships must either work high-pressure or exhaust into the main condenser without a vacuum. By having a separate condenser fitted with an air pump, and into which all the various engines can exhaust their steam, the condensed steam is available for feeding the boilers, the efficiency of the engines is maintained, and a reduction in the coal consumption is the result."

The style of condenser to be adopted for a central plant necessarily depends upon the location. On shipboard the usual form of tubular surface-condenser is naturally used, but for manufacturing establishments

or electrical plants the question of water supply must be considered. Where water is abundant surface condensers will generally be employed, except when the supply is pure enough to be satisfactory for direct use in the boilers, in which case there is no objection to the use of injection condensers, the simplicity of the apparatus and the high vacuum attainable being points worthy of consideration. Where water is scarce, however, it becomes necessary to resort to some means by which it may be economized, and it is the demand for a condenser which is capable of maintaining a good vacuum with a minimum supply of water which has led to the design of cooling towers, evaporative condensers, and similar devices.

Theoretically, the evaporative condenser offers many advantages, since, all other things being equal, the condensation should be effected by the evaporation on the outside of the tubes of a quantity of water equal to that condensed within them. Here, however, as in many similar cases, all other things are not equal, and previously neglected questions, such as the influence of atmospheric humidity, deposition of dissolved salts, etc., etc., crop out to the inconvenience of the engineer. These, however, are minor features, and will doubtless be successfully overcome, and there is every reason to believe that the great heat-absorbing process of evaporation will more and more be called upon to assist in the condensation of steam. At the same time other devices will doubtless come into use, and before a very great while it will be the rule, rather than the exception, for every power plant of reasonable size to be equipped with a central condenser.

The Handling of High Explosives.

THE general introduction of high explosives into use in coal mines in the place of gunpowder has been mainly due to the desirability of avoiding the use of any explosive which may ignite the mine gases, safety being the great point to be attained. There is little doubt that so far as the ignition of firedamp is concerned, the modern explosives are much safer than the old one, but there are other dangers connected with their use which can only be avoided by care and proper supervision. It is of these latter dangers that a carefully written article in recent issues of the *Colliery Guardian* treats, and some of the points are so eminently sensible that they should be emphasised to the utmost.

In the first place, proper care should be given to the storage of explosives, not only with regard to absence of moisture, but also to freedom from marked variations in temperature that decompositions and alterations in character are due. All explosives should be kept in the main storehouse, and not given out to the men in such quantities as will oblige the latter to find some place of their own to keep the surplus until used.

A very important feature is the careful accounting of the whereabouts of all explosives and especially of all detonators. If every miner is charged with the exact number of cartridges and detonators given out to him, and obliged to account for them, or for an equivalent number of explosions, much will be done to insure safety. With such a record accurately kept, there is no difficulty in discovering who the careless individual may be who has allowed dangerous materials to get into irresponsible hands, while the reprehensible practice of using more than one detonator to a charge would be promptly checked. So far as the care of stock is concerned, then, the main points to be observed are to have a dry, well protected place of uniform temperature for storage, under the care of a competent person, and to have every charge accounted for, only giving out each day the estimated quantity required for that day's work and requiring all excess to be accounted for regularly.

In regard to the use of high explosives the same common-sense rule of carefulness should apply. The charge may be prepared a short time before the hole is ready for it, but under no circumstances should the detonator be attached until the last moment. Especial care should be given to the cleaning of the hole, for unless all drillings and cuttings are removed, the cartridge is liable to stick on being inserted. The size of cartridges should be adapted to the diameter of the hole, since cartridges which are too small for the bore are apt to get canted and caught, several thus forming a sort of toggle series which is very apt to jam.

The stemming material should be stiff clay, formed into plugs or cylinders, inserted into the hole and forced into place by firm quiet pressure, blows being altogether forbidden; six inches of such stemming being quite sufficient. When a short stemming is used, there is enough depth of hole left to permit a second charge to be put in and fired should the first charge miss fire.

Every missed shot and unexploded detonator must be recovered. The practice of rolling into the pack blocks known to contain unexploded charges should never be permitted, and a piece of coal containing a missed charge may, if put into the gob, be a cause of a most disastrous fire. The handling of missed shots is best intrusted to a special man, who by acquiring experience in this difficult line will best know how to deal with the various cases which may arise. If the hole has only a short stemming, as described above, a second charge will, in nearly every case, explode the first. If this is not successful a second hole may be drilled, and an experienced man will have no difficulty in determining whether both charges have gone off.

There is a legal requirement, which should be enforced rigorously at every mine, that if a man leaves his place with a missed and unrecovered shot therein, the place must be fenced off, and the incident reported to the authorities.

While the various points thus made regarding the handling of high explosives may seem very elementary, it is by the non-observance of just such simple precautions that the greatest disasters are caused, while with a reasonable degree of care, safety may be practically assured.

Steam Pipes and Fittings.

Among the papers presented at the Bristol convention of the Municipal Electrical Association was one by Mr. J. E. Edgcombe upon the arrangement of steam pipes and fittings, which contains some points of interest. It is an excellent example of the close relation which mechanical and electrical engineering bear to each other that a paper so strictly mechanical should have been presented at an electrical convention, but as Mr. Edgcombe said:

"The subject of steam and other piping is one of the greatest importance to engineers of central stations, and indeed, to all who have to deal with steam plant." Since electrical plants are in nearly every case also steam plants, except in those favoured localities where water-power is abundant, the electrical engineer needs to learn all he can about these important details of his work.

The piping system which must be considered in a power station is mainly that which connects the steam boilers with the engines, and as in most case the boilers are placed in a portion of the building adjoining the engine room, the connection may be made in a very direct manner. Mr. Edgcombe expressed himself in favour of the so-called "ring" system, in which the steam main forms a steam-ring running from the boiler house through the engine house and returns again to the boiler rooms where it connects with the starting point. All the boilers, in this system, connect into this ring main, and all the engines draw from it, and by having valves placed between every unit, any single unit or series of adjacent units may be cut out of action without requiring the others to be stopped. The ring system, however, was not given the unqualified endorsement of all those who discussed the paper, and Mr. Ferranti expressed himself as decidedly opposed to this arrangement, involving as it does a great number of valves and connections. He gave preference to the system of running the plant in independent sections, each section consisting of one engine and the boilers necessary to drive it.

The importance of giving attention to the valves was also discussed and some valuable practical points elicited. One of the most frequent causes of trouble with valves lies in the carelessness which permits dirt, chippings, etc., to be left in the piping when it is first connected up, as this matter is gradually carried along with the current and lodges upon the valve faces, causing cutting and injury: no small portion of the leakage so common with steam valves may be traced to this cause.

The question of expansion and contraction is always an important one in connection with long lengths of piping, and not-

withstanding the attention which has been given to expansion joints it appears that no wholly satisfactory method of providing for the expansion of steam pipes under pressure has yet been devised. Packed stuffing-box joints gradually become hard and rigid, and better results are obtained by using copper expansion bends, but the increasing use of high-pressure steam brings in the uncertain element of the diminution in strength of copper under high temperatures.

In electric plants the great thing is the necessity of maintaining the plant in operation, at least partially, under all circumstances, and the possibility of a complete stoppage ought to be most remote. For this reason it should be possible to throw any boiler or engine out of service without interfering with the others, and should a pipe burst or a valve fail, the loss of steam should be automatically checked. Valves for this purpose are made, and, when placed between the boilers and the steam main, these close when any great difference in the equilibrium on either side occurs.

The great remedy for trouble with steam piping lies in frequent and careful inspection. Valves should often be opened and tried, pipe hangers and supports examined to see that expansion strains are not working injury, while any symptom of leakage at flange joints or stuffing boxes ought to receive that prompt attention which prevents further and more serious trouble. There is little doubt that the very important subject of steam piping is rapidly being taken out of the hands of the steam-fitter and placed in those of the engineer and the results should prove of material benefit to the safety and convenience of the power-plant.

The Port of Calcutta.

THE port of Calcutta is at present the subject of much discussion, improvements being necessary and the character and extent of them being a most difficult problem. Two articles relating to this subject contain much matter of interest, one being an address by Sir Charles Cecil Stevens before the Society of Arts, and the other an article in the *Indian and Eastern Engineer*, both showing the necessity for improvement in the trade facilities of Calcutta if the city is to retain its commercial importance.

The address of Sir Charles Stevens contains much very interesting matter concerning the history of the city and its commerce, and shows how difficult the control of the Hooghly river always has been. Calcutta is situated about eighty miles from the mouth of the Hooghly, and for about forty miles from the city towards the mouth the river maintains a distinct limit, that is to say, as far as the point called Diamond Harbour, while the remainder of the distance constitutes the estuary, filled with shifting shoals, and tortuous channels to the sea. It is the upper portion, extending from Calcutta to Diamond Harbour, which now demands the attention of the Port Commissioners, since there have been frequent alarms caused by changes in the river bed in this section.

Several plans have been proposed to avoid the difficult navigation in this portion of the stream, some involving the construction of canals for a greater or lesser portion of the distance, others including the construction of embankment works which should control the current and compel it to scour its own path, while the direct and definite idea of using powerful dredges to cut and maintain an ample channel, is also being considered.

In addition to the necessity for improvements in the channel of the river the question of increased accommodations in the port demands attention. The want of docks is being increasingly felt and although various sites have been considered none have been found acceptable except that at Kidderpore, where since 1892 the dock has been open and in use. At first there was little disposition shown to use the dock, but by 1895 the income began to meet the expenses, although the interest and taxes had to be met by the port dues.

As the jetties became more and more crowded the Port Commissioners decided to permit their use for imports only, thus compelling the export merchandise to be handled at the dock, and now ships of all lines go to the dock and many people are wondering how they ever got along without it. The jetties have nominally lost the business which the dock has gained, but in fact the commerce of the port has increased

to such an extent that the receipts of the jetties are practically as great as before the dock was in use. With the increase in the coal trade demand has arisen for increased accommodation, so that the construction of a second dock has become a matter for serious consideration.

As a counterpart to these plans for the improvement of the port may be noted the efforts to secure increased railway facilities from the upper provinces and the coal fields of Bengal to Calcutta. That this is a feature well worthy of consideration is shown by the fact that the total traffic of the East Indian Railway has more than doubled between 1890 and 1897, and that more than 67 per cent. of the total increase is in coal, which now forms more than one-half the total traffic. With the various railway extension schemes which are under discussion is involved the Central Railway and Hooghly bridge, and the principal difficulty which this project encounters is the fear of any further direct levy on the trade of the port. The welfare of the whole city is, however, included in all the transportation facilities, both by land and by water, and the importance of the interests involved should cause this mutual dependence to be realised.

When so many important engineering problems are being earnestly discussed some material results should certainly follow, and the work of the engineer will in any case be required to assist Calcutta to maintain her position as a trade center.

REVIEW OF THE CONTINENTAL PRESS

The Simplon Tunnel.

ONE year ago the first actual constructive work was begun upon the Simplon tunnel, the latest and greatest of the undertakings connecting Italy by all rail with Switzerland, and from an article by Baurath H. Claus in a recent issue of *Glaser's Annalen*, a very complete account of the origin and details of the undertaking are obtained.

Until now there has been no complete rail connection between western Switzerland and Italy, and to reach Milan it has been necessary to go around to Lucerne and so on through by the St. Gotthard route. The Jura-Simplon railway from Geneva around the lake and up the Rhone valley, ascends to Brieg, at an altitude of about 2,300 feet, while on the Italian side the railway from Milan stops at Domodossola, at an altitude of 900 feet. Between the two lies the famous Simplon Pass, the distance between the two towns being 41 miles, over an elevation of 6,590 feet above the sea. Connection is now made by diligence, but this occupies nearly all day, and is available for passengers only, hence the plan to connect the railways by extending the road on the Italian side as far as practicable, and then to pierce the mountain by a tunnel.

The advantage of such a railway connection will be seen when it is understood that the distance from Milan to Calais by the Mont Cenis is 680 miles, by the St. Gotthard 665 miles, and by the Simplon only 585 miles. The distance from Ostend to Milan by way of the St. Gotthard is 59 miles longer than by way of the Simplon.

Herr Claus gives a review of the various schemes which, since 1857, have been proposed to pierce the Simplon, some of the earlier plans having been made in view of possible financial assistance from France on account of the benefit which would accrue to French trade, but the present undertaking is wholly a Swiss one, the concession having been granted by the Swiss and Italian Governments to the Simplon Tunnel Company, which is practically controlled by the Simplon-Jura Railway.

The plans included the prolongation of the railway on the Italian side from Domodossola to Iselle, about 2,100 feet altitude, where the Italian entrance to the tunnel is made, and here the first work was started in August, 1898. On the Swiss side the entrance is at Brieg, and the tunnel will connect the two stations of Brieg and Iselle, being 64,735 feet, or 12.26 miles long. This is nearly 3 miles longer than the St. Gotthard tunnel, but the altitude is less, being only 2,300 feet above sea instead of 3,800 feet, as at St. Gotthard.

In plan the tunnel is to be straight, with a short curve outside of each entrance connecting with the approaches, the highest point being almost at the middle, with a grade of 1 in 143 on the Italian side and 1 in 500 on the Swiss side. The principal difference between the tunnel and those previously pierced through the Alps lies in the fact that instead of one single tunnel two tunnels are to be constructed side by side, running parallel to each other at a distance of 55 feet from centre to centre. This construction enables a double track railway to be carried through without involving the removal of so much rock as is necessary in the case of a single double-track tunnel, and constructively the plan possesses several advantages.

At first but one of the two tunnels is to be completed to the full dimensions, the other being carried through at only about one-fourth the area of the ultimate cross section, connecting passages being pierced every 650 feet to communicate with the other finished tunnel. The one complete tunnel will then be used as a single-track passage until the demands of the traffic shall render it advisable to complete the way for the second track, and in the meantime the smaller parallel passage will be used as a ventilating flue, fans being connected as may be found necessary. The second tunnel will also be used to drain the water from the first one, and thus the work of completing the full sized passage is expected to be greatly expedited. Both tun-

nels are now being bored by the use of the Brandt hydraulic rotary drills, water being supplied at a pressure of 70 to 100 atmospheres through two 4-inch pipes, there being twelve machines in all now in use, with a total consumption of about 40 cubic feet of water per minute at a pressure of 70 to 100 atmospheres. The borings are to be made through gneiss, micaceous limestone, and slate, holes 2¾ inches in diameter and 4 to 5 feet deep being bored and the rock brought down by the use of dynamite. A narrow gauge railway is employed to remove the débris, the smaller tunnel being used for the discharge and the track in the main tunnel for the return.

The entire work is mapped out in a programme, which contemplates the completion of the one main tunnel and the smaller auxiliary tunnel in five and a half years, the allotment for each year being increased as the facilities for the work are augmented. The work of the first year includes the erection of the extensive power plants and workshops at each entrance, and at the close of 1898 there had been completed about 300 feet of boring on the south side, and 1,300 feet on the north.

The cost of the work is divided into three parts as follows:

	Francs.
1. Preliminary work, including surveys, plant and track..	7,000,000
2. Boring one complete tunnel and the small auxiliary.....	47,000,000
3. Completing auxiliary tunnel..	15,000,000
Total for the complete double-track tunnel.....	69,000 000

If these figures are not exceeded the cost of the tunnel per metre will be 3,475 francs. Some comparisons with the costs of the other Alpine tunnels will be of interest in this connection. The Mont Cenis tunnel, the first to be built, cost 75,000,000 francs, or about 6,130 francs per metre, but this high cost was partly due to the protracted period over which the work extended, as well as to the absence of modern tunnelling machinery. The St. Gotthard tunnel cost 59,750,000 frances, or 3,984 francs per metre, so that the Simplon tunnel will cost very little more per metre than the St. Gotthard, notwithstanding the greater length. The above cost is for the tunnelling only and does not include the construction of the permanent way.

The Marseilles Canal.

In former times the port of Marseilles profited very greatly by the traffic which passed from central and northern France eastward on the Mediterranean, but since the completion of continuous railway communication through the Alps much of this trade has passed on to Genoa, and Marseilles has suffered accordingly

Before the opening of the Mont Cenis tunnel the eastern mails were sent from Marseilles, but this business is now transferred to Brindisi. The completion of the St. Gotthard tunnel has placed Genoa within 315 miles of Bâle, while the distance from Bâle to Marseilles by railway is more than 450 miles, hence nearly all the merchandise sent from England, Belgium, Holland and German Switzerland goes by rail to Genoa by way of Bâle. When the Simplon tunnel is completed the commercial importance of Genoa will be still further increased, and as nearly all of this traffic will be diverted from Marseilles the consequences to the latter port are most serious.

Various plans have been proposed to enable Marseilles to maintain her position in the face of this increasing competition. A railway from Chagny to Hirson has been discussed, and such a road would result in a gain of nearly 60 miles over the St. Gotthard route, but constructive difficulties have caused this plan to be given up.

The most probable solution of the problem lies in the development of cheap and convenient water transport connecting Marseilles with the region from which its traffic must be drawn, and in a recent issue of *La Revue Technique* the proposed canal from Marseilles to the navigable waters of the Rhone and its tributaries and connections is discussed and its capabilities set forth.

The Rhone, with its canal connections with the Seine, the Loire, and the Rhine, affords a general access to the interior of western Europe, but the shifting sand bars and obstructions at its delta render navigation difficult at the mouth. For this reason a short canal has been made from St. Louis to the Gulf of Fos, giving access from the Mediterranean to the navigable channel of the Rhone for vessels of not more than 18 feet draught. This canal, however, does not admit of direct delivery to the port of

Marseilles, and hence the plans have been made for a complete waterway from Marseilles to the Rhone at Bras Mort, a distance of 34 miles.

The construction of the canal, as shown in the various sections, is of interest. On leaving Marseilles it will skirt along the shore of the bay of Madrague, the channel being formed by a dike and breakwater separating the water of the bay from the channel. It then makes a sudden turn and pierces the mountain which separates Marseilles from the lake called Etang de Berre, a tunnel 4½ miles long being necessary. The channel will then be carried around the side of the lake, and then pass through to the Gulf of Fos, an open cutting only being necessary in this case, and from thence in a straight line it proceeds to Bras Mort on the Rhone, at a point where there is a depth of 20 feet of water, and from which steamboats of 1,000 tons displacement can reach a country within a radius of more than 300 miles. In this way access will be given from Marseilles by the Rhone to Lyons, and by the Saone to Chalons, while through the existing system of internal waterways boats of 300 tons can reach Nancy, Paris, Havre and Lille.

Since the cost by water transport, especially for heavy merchandise, is only about one-half what it is by rail, the completion of this important water-way, with its connections, should restore in large part the merchandise traffic which has been taken from Marseilles by the railways. This is especially true of bulky merchandise, in which the expense of transport forms a large proportion of the total cost, and it may be expected that for the transport of coal, minerals, metallurgical products, fertilisers, cereals, wines, etc., the water-way will command the traffic. The construction of the canal may therefore be said to interest not only the port of Marseilles, but also the whole of France, since the influence which this cheap outlet will have upon French products must be stimulating.

The total cost of the canal is estimated at 80,000,000 francs, of which one-half is provided by the local interests, including the Department des Bouches du Rhone, the municipality of Marseilles, and the Chamber of Commerce, and the work is expected to be completed in ten years.

The Sterilisation of Potable Water.

ALTHOUGH it has been known for some time that water could be sterilised by contact with ozone, the data concerning the working of the process on a large scale have not hitherto been available. We now have, however, a report of a commission appointed by the municipality of Lille upon the practical operation of the process as there installed by MM. Marmier and Abraham, and from a communication by the latter to the French Academy some details are here abstracted.

The apparatus used at Lille may be divided into three parts, the electrical generator, the generator of the ozone, and the sterilising apparatus proper.

The electrical apparatus offers no features of especial interest, except that the primary current is raised by a suitable transformer to a pressure of 30,000 volts. The ozone generator utilises this current to produce sparks between suitable electrodes, the electrodes being cooled by a separate internal circulation of water, this cooling of the electrodes being considered as quite an important feature in the production of ozone on a commercial scale.

On leaving the generators the ozone enters a masonry tower, where it meets the water to be sterilised, the circulation being controlled so that an intimate and thorough contact is assured.

The water has been previously filtered, so as to remove all solid impurities, and the contact with the ozone is intended to destroy the bacteria which may be in it.

After the installation at Lille had been in use for several months a commission of experts, consisting of such notable specialists as Dr. Roux, of the Pasteur Institute at Paris; Professor Buisine, of the Faculty of Sciences at Lille; Dr. Calmette, of the Pasteur Institute at Lille, and Professor Bouriez, was appointed to make a report upon the working of the plant.

Only the conclusions of the report are given, from which the following is obtained:

All pathogenic or saprophytic microbes which were found in the unsterilised water were entirely destroyed by the passage of the water through the ozonising tower. The only germs which resisted this action were a few of the kind known as *Bacillus*

subtilis, this being the microbe which is found in hay, and being entirely harmless either to man or to animals. It is interesting to note that this microbe also resists the action of steam at a temperature of 110° C.

The ozonisation of the water introduces no element whatever which can be injurious to the health of those using it; on the contrary, since there is no increase in the nitrates and a considerable decrease in the quantity of organic matter present, water which has been subject to the ozone treatment is much less liable to subsequent pollution.

It is unfortunate that nothing is said in this communication about the cost of the sterilisation of water by this process, and it is to be hoped that data as to the number of cubic metres which can be sterilised by a kilowatt of electrical energy may be obtained from this important installation. In many cases power is available where pure water is not to be had, and the introduction of electrical sterilisation becomes a question of cost alone. In connection with hospital service also the importance of obtaining a reliable supply of sterilised water can readily be appreciated.

In this connection it may be mentioned that M. E. Andreoli, in a communication to *L'Electricien,* calls attention to the fact that the use of electrodes cooled by water circulation in the production of ozone is his invention, and shows that he used this method before 1896.

Steam Engines for Rolling Mills.

AMONG the papers read before the recent convention of the *Verein Deutscher Eisenhüttenleute,* at Düsseldorf, was one by Herr C. Kiesselbach upon the subject of engines for rolling mill service, which contained an excellent review of the requirements of this exacting branch of work.

Before discussing the general details of rolling-mill engines, Herr Kiesselbach showed the great advantages which compound engines offer for this service. Owing to the variable nature of the load the point of cut-off must vary very greatly in single cylinder engines, and as steam is often carried full stroke the loss from clearance and internal condensation is often large, while if condensing engines are used the sudden discharges of high-pressure steam when working under heavy loads renders it difficult to maintain a satisfactory vacuum. For these reasons compound engines are greatly to be preferred for rolling-mill use, a wide range of power being available, while at the same time good economy is obtained. It is true that compound engines have not showed so high a steam economy in rolling mill service as has been obtained in spinning mills and other factories where the load is practically constant, but this is not to be expected, and a more just comparison is had by observing the performance as compared with single-cylinder engines in rolling mills.

In order that an ample reserve power may be had for emergencies it is advisable to use a somewhat smaller cylinder ratio than would otherwise be adopted, and good practice varies between the ratios of 1 : 2 and 1 : 2. 3; and the cut-off in the low-pressure cylinder should not be set too early or the pressure in the receiver may occasionally back up too high. Triple-expansion engines are not so well adapted as compound engines for rolling-mill use, since the sudden changes of load occur too rapidly for a change in regulation to affect all three cylinders in time, as is plainly shown in indicator diagrams.

The cross-compound engine with cranks at 90° has almost disappeared from German rolling mills, preference being given to the tandem compound. The general arrangement is as follows: The high-pressure cylinder is placed in front, or nearest to the crank, and the forward cylinder head is either cast in, or arranged so that the joint can be packed without taking down the engine. The two cylinders are connected by a trunk of such a section that its center of gravity coincides with the axis of the piston rods. The front head of the low-pressure cylinder is arranged so that it can be inserted from the rear end of the cylinder, and the bore and flanges are so proportioned that the rear head of the high-pressure cylinder can be drawn out through the low-pressure cylinder. By removing the rear head of the low-pressure cylinder, and disconnecting the piston rod from the cross head, both pistons and heads may be withdrawn together with the rod. This operation is facilitated in the case of large engines by

having an opening in the upper part of the connecting trunk, so that supporting chains from an overhead crane may reach the rod. No guide is necessary between the two cylinders if the pistons are not made too heavy and are provided with sufficient bearing surface.

Most of the tandem compound engines are built with fly wheels, but a similar construction is adopted for reversing engines, and notwithstanding the higher steam consumption the latter style is coming more into general use.

Herr Kiesselbach's paper is accompanied with numerous plates, showing very fully the construction adopted by several of the leading engine builders of Germany, while details of bearings, pistons, packings, and other parts are fully given.

The advantages of superheated steam are discussed, and a superheating of 80° to 100° C. above the temperature of saturated steam is said to require no especial modification in the engines in which it is to be used. When, however, a high degree of superheating is employed by which is meant an elevation of temperature to about 350° C., it is necessary to provide for the action of such steam upon the joints and packing. Special designs of stuffing boxes for such superheated steam are shown, and emphasis is placed upon the necessity of arranging the working parts so that the temperature may be maintained as nearly uniform as possible in the various portions, in order that distortion from unequal expansion may be avoided.

Balanced slide valves, piston valves, and poppet valves are all used in the various designs, and especial care must be given to the stop valve, this latter being so arranged in some cases that it may be adjusted either gradually by hand or closed or opened promptly by power, and in every case the arrangement of handles and controlling levers is a subject requiring much care and judgment. The operator of a rolling mill engine must have his machine at all times under the most complete and prompt control, and this forms an important feature in all the designs.

The whole paper of Herr Kiesselbach, with the animated discussion which it elicited, forms an important contribution to the record of present rolling-mill practice in Germany, and as such is worthy of careful examination.

It is interesting also to note that in the course of the discussion it was mentioned that electricity is also being employed for this service, a 500 horse power electric motor being successfully used in rolling wire rod of 6 mm. diameter, and it is not impossible that electricity may become widely adopted for driving rolling mills.

Progress in the Use of Blast Furnace Gases.

At the meeting of the *Verein deutscher Eisenhüttenleute* last year a paper was read by the well-known metallurgical engineer, Herr Fritz Lürmann, upon the use of blast furnace gases for motive power when used direct in gas engines. At that time he expressed himself rather unfavorably, basing his criticisms mainly upon the injurious effect which the dust in the gases might produce in the cylinders, besides urging other objections.

In a second paper, presented at the recent meeting of the same society at Düsseldorf, Herr Lürmann discussed the progress which has been made in the application of furnace gases to motive power, and shows that most, if not all, of his former objections have been modified or removed during the interval which has elapsed.

The principal bugbear, the dust, seems to have been found amenable to control, notwithstanding the difficulties which appeared at first. The dust which is discharged with the gases from a blast furnace comes both from the ore and the fuel, and may be divided into three kinds. The first portion is the coarse granular dirt, which is so heavy that it is deposited in the first passage after leaving the furnace or in the dry purifiers, and does not reach the engine at all; the second portion is much finer, but with care can be removed by wet scrubbers before the engine is reached; the third portion is a very fine, impalpable powder or soot, partially thrown down during the combustion of the gas, and not removable by any preliminary process. This finest dust, therefore, must be expected to appear in the cylinder, and, although it is not of a nature to cut the surfaces, it forms a thick mass with the lubricant, especially at the

high temperatures at which the latter is already beginning to be carbonised. Notwithstanding the fact that this dust is deposited in the cylinder, practical experience has shown that no serious results follow, and the engines which have been operated with furnace gases during the past year have experienced no serious trouble from clogging in the cylinders.

Taking the performance of several engines of which complete tests have been made public, it appears that the use of blast furnace gases for motive power in gas engines is entirely practicable from a mechanical standpoint, and hence Herr Lürmann proceeds to discuss the subject from an economic point of view. To this end he undertakes to answer the two questions: How much power can be obtained from the gases produced in the reduction of a given quantity of iron; and, How much money is to be saved?

At the present time these questions can only be answered upon theoretical grounds, but the conclusions thus reached may be checked by the limited number of observations available, and the probable percentage of the theoretical gain which may be expected can be determined.

In the production of a ton of pig iron there are generated 165,000 cubic feet of gas, of about 100 B. T. U. thermal value per cubic foot. Of this about 28 per cent. is required for the heating of the blast, while about 10 per cent. may be estimated as lost by leakage and escape. The remainder may be used in any one of three ways: all may be burned under steam boilers; a portion may be used under boilers and a portion in gas engines; or, all may be used in gas engines. In the first case about 40 per cent. will be required to produce the power required by the furnace, leaving 22 per cent. available for other purposes; in the second case the same is true; while in the third case only about 11 per cent. is required for the furnace power, leaving more than 50 per cent. available for profit. The principal difference between the first and second cases lies in the fact that in the one only about 3½ h. p. per ton can be produced, while in the other, 12½ h. p. is obtained. This is due to the fact that the gas engine is so much more economical than the steam engine.

The production of pig iron in Germany during 1898 averaged 20,280 tons per day, and Herr Lürmann computes that if all the excess gas were burned under steam boilers, about 70,000 h. p. would be generated, while if utilised in gas engines the available power would be 253,500 h. p., and if the total of the discharge gases were thus converted into power the amount would be about 570,000 h. p. This last supposition involves the substitution of gas engines for steam as motive power at the furnaces, and includes the successful design of gas-power blowing engines, but there is no reason to assume that this problem may not readily be solved.

The value of the introduction of the last named use of the gases is stated by Herr Lürmann as follows:

Taking the gain of power as 500,000 h. p. per day of 24 hours, or 4,380,000,000 h. p. hours for the year's iron product of Germany, and assuming that one h. p. hour could have been produced by one kilogramme of coal, the fuel value of this power is 4,380,000 metric tons, and taking coal at 10 marks per ton, we have a profit of nearly 6 marks per ton of iron, or allowing 50 per cent. for losses and attendance there might be a money value of 3 marks for every ton of iron produced, a value which is now thrown away.

In all his computations Herr Lürmann has rather erred on the side of conservatism, and the details of his figures are given in full, so that in this important paper we have a full, critical analysis of this question given by one who began his investigation with rather a prejudice against the practicability of the idea. Under these circumstances it certainly appears as if the saving of the vast amount of power at present wasted cannot be deferred, not only in Germany, but everywhere where iron is produced and power utilised.

The Ventilation of the St. Gotthard Tunnel.

From its first operation the St. Gotthard tunnel has been noted for its excellent natural ventilation and freedom from smoke, being in this respect a notable improvement over the Mont Cenis tunnel.

The increase in traffic, however, has led to the operation of a much greater number of trains than formerly, and hence the

natural current of air has been found insufficient to keep the tunnel free from smoke. The increase will be seen from the statement that in 1888, 32 trains passed through the tunnel in 24 hours, while in 1897 the number of trains reached 61, practically double.

In a recent issue of the *Schweizerische Bauzeitung* the discussion about the ventilation of the tunnel is given at some length, together with an illustrated account of the new plant which has been installed at Göschenen, at the northern portal, where a ventilating plant on the Saccardo system has been erected.

Before attempting artificial ventilation it was suggested that compressed air, or electricity be employed as a motive power in hauling trains through the tunnel, and before resorting to such a radical change experiments were made with smoke burning devices and with smokeless fuels. It was finally decided, however, to assist the natural current, which grows sluggish when the pressure on the northern side becomes nearly equal to that on the lower, by providing a pressure blower system to maintain the air current from north to south.

The general arrangement of the ventilating plant is simple. A power-house containing the motive power and two large pressure blowers, was constructed near the north portal, and air conduits led to a chamber just within the entrance. Here two annular passages were constructed, each reaching half way around the periphery of the tunnel, the passage above being connected with one fan, and that below with the other, and both opening into the tunnel itself. The two fans, each of which is 5 metres in diameter, are mounted on the same shaft, with a grooved pulley between, and in the preliminary experiments they have been driven by a locomotive, the axle of the engine being coupled to a second shaft carrying a grooved pulley, and rope transmission being used to the fan-shaft. When the plant has been in service long enough for sufficient experience to be had as to speeds, capacities, etc., it will probably be driven by transmission from some convenient source of water-power.

The principal feature of the Saccardo system lies in the surrounding of the tunnel passage with an annular ring delivering air into the entire periphery, thus preventing the formation of lateral currents, and at the same time inducing a suction of air into the mouth of the tunnel. Experience with the system in the Pracchia tunnel through the Apennines, on the Bologna-Pistoia line, has been satisfactory, and from the brief trials which have been had at Göschenen it is believed that there will be no difficulty in maintaining a current of 3 metres per second from north to south regardless of atmospheric conditions.

Refuse Destruction in Berlin.

Ever since it has been shown that a commercially valuable amount of power can be obtained from the burning of municipal refuse, attention has been directed towards possible improvements in refuse destructors and their attached steam plants.

A recent issue of the *Gesundheits-Ingenieur* contains a review of the performance of the new Wegener destructors now in operation in Berlin, and the experience which has been gained in the operation of this plant is of material value for future information. The important feature in every successful refuse destructor is the production of a high temperature within concentrated limits, since the difficulty with which some portions of the refuse ignite causes the combustion otherwise to be very imperfect. For sanitary reasons alone it is important that every particle of organic matter be consumed and reduced to an inorganic state, while naturally the highest thermal efficiency can only be reached with complete combustion.

The Wegener furnace aims to accomplish this result by the use of pulverised fuel instead of firing with coal or coke. When solid fuel is used it is found necessary to use an air-blast in order that the necessary temperature of 1,600°—1,800° C. be reached, and, unless some form of regenerative system be used to heat the air, this method involves intermittent cooling during the intervals of firing, while it is of the utmost importance that a constant and practically uniform high temperature be maintained if successful results are to be secured. By the use of pulverised fuel, introduced continuously with the air blast,

no interruption occurs either in the supply of fuel or air.

The principal criticism which has been made of the Wegener system of firing, when applied to ordinary boiler furnaces, is the cost of pulverising the coal, but when, as in the present plant, a double duty can be obtained, this point becomes a secondary consideration.

When the system of firing a destructor with pulverised fuel is employed, a temperature of about 1,400° C. is produced in the discharge gases after they have acted upon the refuse, and this is a higher temperature than is usually experienced in the flues of a boiler furnace. This is partly due to the fact that in the Wegener furnace the air blast is heated by passing through a flue at the base of the chimney, and also to the additional heat produced by the burning of the combustible portions of the refuse.

When such a high temperature as that obtained by firing with powdered fuel is secured there is found to be no necessity for sorting the refuse, since everything is either burned to gas or else fused into slag, all being rendered innocuous and much more available as fuel.

The Berlin destructors are masonry structures each formed in three stages, one above the other. The upper portion contains the charging chambers, into which the refuse and powdered fuel are dumped, being raised to the top by electrically-driven conveyors. In this stage the fuel and refuse are separated from each other by a partition wall. From this stage the materials fall through hoppers into the second portion, where a sort of dry distillation takes place, the heat being supplied by flues through which the discharge gases from the furnace pass; these chambers are formed of large sheet metal cones which slowly revolve, and make a thorough drying possible without clogging. From these cones the refuse and fuel fall into the lower, or combustion chamber, where they meet a powerful hot-blast of air, and where the burning of the powdered fuel produces an intense heat, everything combustible being completely burned, while the non-combustible matter is fused to a liquid slag, which collects on the bottom of the chamber, and can be drawn off, and cooled to a brittle, glassy cinder.

The completeness of the combustion is shown by the fact that no smoke appears at the chimney, although the gases are cooled by having the greater portion of their heat abstracted from them by being passed through the boilers of the attached steam plant.

According to the *Gesundheits-Ingenieur* the plant is very satisfactory as a sanitary method of disposing of the refuse, and although detailed trials are not yet made public, it is believed that the efficiency of the steam plant makes it also a commercial success.

REVIEW OF THE AMERICAN PRESS

The American Society of Civil Engineers.

AT the recent convention of the American Society of Civil Engineers a number of important topics were presented and discussed. The address of the President, Mr. Desmond Fitzgerald, dealt mainly with the historical side of civil engineering in America, and contained some very interesting information about early engineering works and the men who constructed them.

Almost immediately after the close of the Revolutionary war, engineering works were contemplated and undertaken, but it was then deemed necessary to send to Europe for trained engineers. The first important work was the Potomac canal with its locks around the Great Falls, a work in which Washington was interested. The work on the Santee canal, in South Carolina, was under the superintendence of Colonel Christian Senf, a Swedish engineer, while the early works of the Schuylkill and Susquehanna Navigation were under the charge of an English engineer, William Weston. Weston also supervised the canals which were constructed in the Mohawk and Hudson valleys, and ran the levels for the Middlesex canal, in New England, and the first great engineering work which was executed solely by American engineers was the Erie canal, Geddes, Wright, Brodhead, and their assistants carrying the great work through to success between 1817 and 1825. From this time onward most of the engineering work in the United States was done by Americans, experience and opportunity producing the many able men whose names are given by Mr. Fitzgerald. The early work was mainly canal construction, followed by bridge construction, docks, and later by railroading.

All this relates to civil engineering pure and simple, for in mechanical engineering the names of Oliver Evans, John Stevens, and Robert Fulton antedate those of the pioneers in the allied branch. Mr. Fitzgerald's address contained much matter of more than mere historical interest, and is a most worthy record of the work of the predecessors of the modern leaders of the profession, all of whom are proud to render honor to the founders of civil engineering in America.

Of the discussions and papers presented at the convention only the most important features can be here noted. The questions involved in the assumption of loading in connection with bridge design brought out a very sensible line of thought, *i. e.*, the desirability of arriving at the real conditions, even if this can be done only approximately, rather than to make refined calculations of precise appearance but of doubtful accuracy. When such competent speakers as Gustav Lindenthal and George S. Morison attack the subject of false refinements, and go straight to the actual conditions which obtain in practice, some very definite conclusions may be expected. One point especially made by Mr. Morison is worthy of note, namely, that the type of engine which is used in testing a bridge becomes obsolete long before the bridge is worn out, and in fact a bridge should always be planned for future requirements rather than for present use.

The question of the contamination of streams by sewage was brought up in an effective manner by a protest from St. Louis engineers against the discharge of the drainage of the Chicago canal into the Mississippi, and there seems to be little doubt that this matter will demand a solution of some sort before very long. As the subject now stands there is no legislation against the pollution of streams, and it is believed that some action by the society would have weight with Congress, as this is a matter in which federal action is necessary. Methods of sewage purification were discussed, but so long as it is possible to pass the wastes on to some other locality it will be difficult to introduce any such plants.

Another prominent discussion was that upon the question of the applicability of electricity to main-line railways, and it is rather interesting to notice how the views of the various speakers indicated their pres-

ent affiliations. It is very difficult for any railroad man to see anything good in electric propulsion for anything but local and suburban traffic, and the possibility of railway traffic ever becoming modified because of the use of electricity is something which the orthodox railroad engineer does not want to think about. Colonel Haines showed that electricity was more suitable for light, frequent trains than for heavier ones running less often, but no one seemed to see in that an argument for running light, frequent trains altogether, obvious as the suggestion might appear. The fact that the fuel-saving of power houses over locomotives is not great was brought out strongly in opposition to the use of electricity, but the absence of reciprocating parts, and the advantages of independent motor cars were features altogether too radical for the average railroad man to accept. It must not be forgotten that the traffic conditions, which are assumed to control the subject, are themselves the creation of the present railroad system, and that a new system may create new traffic conditions adapted to its capabilities, and none the less effective because they happen to be different from those which now exist.

No one doubts that if aerial navigation should become a practicability an entirely new set of traffic conditions would instantly be created, and the old conditions would be altogether powerless under such circumstances. When the mechanical conditions which are necessary to adapt electric traction to main line service are fulfilled the traffic conditions may be found equally powerless.

An important paper was presented by Colonel Raymond upon breakwater construction, with especial reference to the Delaware breakwater, recently completed, and of which a detailed account was given.

Coal-Cutting Machinery.

THE substitution of machinery for manual labor in the cutting of coal is a noteworthy example of the work of the engineer in a field where it was most needed, and the history of the invention and introduction of these machines forms the subject of an important paper, presented, with the permission of the Director of the United States Geological Survey, before the American Institute of Mining Engineers by Mr. Edward W. Parker.

The earliest patent for an under-cutting machine was issued to Simkins in 1858, since which time no fewer than 468 patents have been issued. Mr. Parker, however, wisely limits himself to a discussion of those machines which have survived the test of practice and have shown by actual use the success of applying mechanical methods to the mining of bituminous coal.

The machines used for cutting bituminous coal may be divided into three main classes: Pick machines, shearing machines and chain machines; these latter also including long-wall machines.

The pick, or punch, machines consist practically of a horizontal cylinder, the piston-rod of which terminates in a chisel-like cutting tool which punches its way into the coal when a reciprocating action is given, compressed air being the motive power. The machine is placed upon an inclined platform, and traverses along the face of the coal as close to the floor as possible, the tool cutting a channel under the mass in such a manner as to leave it in good shape for blasting and loading.

Since 1894 the pick machine has had to contend with the chain under-cutting machine, this operating upon an entirely different principle. In this form of machine the work is done by cutters attached to the links of an endless chain, the action being of a planing nature instead of punching.

"In the attack upon the coal the cutting parts operate at right angles to those of the cutter-bar. The chain, with its cutting-bits, is driven, either by compressed air or electricity, as the case may be, at a speed of from 250 to 275 feet per minute, and the movable frame, carrying the chain and the motor, is fed forward at a speed determined by the resistance offered by the coal. The rear end of the machine is securely held in place by means of a jack, set to the roof, while the forward end is secured by a jack set at an angle of about 45° into the face of the coal. The forward jack is placed at this angle in order to overcome the tendency of the machine to be forced sideways as the chain cuts the coal.

"One of the most notable, and, so far, practically the final step in the development of a successful mining machine was

made when the chain machines were brought out. The speed with which one of these machines will do its work seems almost incredible. An average of five minutes, after the machine is in position, is required to make a cut 6 feet deep, 44 inches wide and 4½ or 5 inches high, and to withdraw the cutting-frame, is the ordinary measure of the effectiveness of this type. A record of 1,700 square feet of cutting in nine and a half hours is claimed for one of these machines. This would mean about seven and a half minutes to each cut 6 feet deep and 44 inches wide, including the moving and setting of the machine."

Shearing machines are made to operate also with the endless chain, the cutting being done in a vertical instead of a horizontal plane. The long-wall machines, although on the same fundamental principle as the chain machines do not require the chain, as the less depth of cut renders it possible to mount the cutters on a revolving horizontal disk, but otherwise the general arrangement of the mechanism is the same as in the chain machines.

The introduction of these various kinds of coal-cutting machines has had much to do with the great increase in the amount of coal mined during the past few years, and this again has been a potent factor in the reduction in the cost of coal to consumers, the average price of coal at the mines having declined from $1.12 in 1887 to 81 cents in 1897. The number of machines in use has increased from 545 in 1891 to 1,446 in 1897, the tonnage mined by machinery in the United States having increased from 6,211,732 to 22,649,220 during the same period.

The Testing Tank at Washington.

THE completion of the new government testing tank at the Washington Navy Yard has been the occasion of the publication of some excellent accounts of this important adjunct to the Construction Bureau, and interest has been added to this work by the liberal manner in which opportunity was given to the members of the American Society of Mechanical Engineers to inspect the tank, and to have its construction and operation explained. From the various accounts which have been published we may refer to one in *Engineering News* as being from the pen of Naval Constructor D. W. Taylor, whose experience in the construction and operation of the apparatus renders him especially qualified in this respect.

The early experiments of Froude, in 1870, although made with a small tank, demonstrated the importance and value of the method of studying hull designs by experiments with models. Since Mr. Froude's death his work has been continued by his son at the larger tank built by the British government at Haslar, near Portsmouth, and tanks have been built by the Italian and Russian governments as well as by the private firm of Messrs. Denny, at Glasgow.

The Washington basin has been constructed from an appropriation of $100,000 made about two years ago, but the completion of the work was somewhat delayed by the war with Spain, so that the entire apparatus is only now ready for service. It is contained in a special building 500 by 50 feet, the tank being 43 feet wide, 14 feet 8 inches deep in the centre, and 470 feet long. The carriage, by which the model is towed and upon which the recording instruments are mounted, is really a form of electric traveling crane spanning the width of the tank and running upon rails along each side. A lever projects down to the water and is attached to the model to be tested, and the resistance is measured and recorded upon a revolving drum by means of an ingenious spring dynamometer. The speed of the carriage can be varied from 1-10 knot to 20 knots; that is from about 10 feet per minute to 2,000 feet, and the weight of the towing bridge and platform, about 25 tons, acts as a sort of fly-wheel to steady the motion and assist in maintaining a uniform and the recording apparatus, the Washingrate.

The recording apparatus consists of a drum upon which time and distance are recorded in connection with the record of the pen connected with the dynamometer, while a set of pens connected with weighted springs draw at the same time a set of reference lines from which the record of the dynamometer pen can be measured.

Apart from the completeness of the tank and the recording apparatus, the Washington tank is noteworthy because of the greater size of the models upon which the

tests are made. The foreign tanks are made for use with models from 10 to 12 feet long, while at Washington the models are 20 feet long, an increase of nearly five times the displacement over a 12-foot model, with a corresponding increase in the reliability of the results. Special attention is also given to the purity of the water and to the uniformity in temperature, a system of warming pipes being arranged for use when the external temperature requires it.

In the European tanks the models have always been made of paraffine, but at Washington it has been thought advisable to use wood, both on account of the warm weather in which much of the work will have to be done and also because of the larger size of the models. The use of wood requires some ingenious tools for the rapid reproduction of the lines of the vessel under test, and the model building shop forms a most interesting adjunct to the tank.

From the drawings of the proposed vessel a number of cross-sections are made, enlargements from the drawing size to that required from the 20-foot model being made by the aid of a pantograph, and upon these cross-sections thin battens are nailed, a model thus being formed. This pattern is then placed in a copying machine constructed on the principle of the Blanchard lathe, and a heavy wooden model for use in the tank is reproduced. The model is carefully measured in order to confirm the accuracy of the work, and is varnished to prevent the water from injuring it, and in this way an accurate reproduction of any hull design which may be submitted can be rapidly obtained. This is the more important because the law authorizing the construction of the tank also authorized experiments to be made for private shipbuilders at the actual cost of the test, providing such work did not interfere with naval tests. With such complete appliances for reproducing the lines of any design which may be sent in, and in view of the fact that the tests for private builders are made at cost, the trial tank should prove an important factor in the improvement of hulls and in the powering of vessels for the navy.

At the present time the staff attached to the trial basin is engaged in making experiments to determine the frictional coefficients needed in connection with the computations upon the tests, and as soon as the preliminary lines of the new cruisers are completed experiments will be made upon them to determine what modifications, if any, are needed.

The Design of Electric Vehicles.

THE increasing use of automobile vehicles and the evident important position which they are destined to occupy in the course of a short time renders some comments upon the designs which have thus far been made public appropriate at the present.

The recent exhibition of electric vehicles at the Electrical Exposition in New York was probably the most complete collection of automobiles which has yet been made in the United States, and from an article in the *American Machinist* describing these vehicles, and especially devoted to the Riker electric wagon, some points relating to the general features of design may be made.

"In spite of the troubles with the tire, due to the great battery weight, there are certain large and highly important fields of automobile effort to which the electric wagon seems better adapted than any other horseless vehicle, and in which these silent, clean, docile and elegant carriages will probably long preserve their supremacy.

"The two principal fields for use for the electric carriage are private carriages for wealthy city dwellers, and the delivery of purchases from the large stores to their customers."

While electricity seems to be in every way the preferable motor for vehicles which are to make short runs on paved city streets, it has not yet manifested its superiority for public cabs, for which the conditions are different, the range of work in this case becoming so great that the storage battery becomes a grievous burden, both to the propelling power and the wheel tires.

An interesting feature about these electric vehicles, however, is the incongruity between the two different portions of the construction, as represented by the work of the engineer and the carriage builder respectively. The railway carriages in Europe still bear the evidence of their origin in imitation of the stage coaches which pre-

cided them, and even where the form of the stage coach body is not retained there are curved external moldings, or perhaps only stripings of paint to give evidence of the evolution, much as the thickened cartilage on the human ear shows where the pointed tip of the simian ancestor once existed.

There is, unfortunately, every evidence that a like absurdity may prevail in the case of the design of motor vehicles. When the designer is concerned with purely mechanical or electrical problems he shows a singular freedom from the influence of precedent, and as the article above mentioned demonstrates the mechanical details are worked out with an ingenuity and skill which can only appear when the end to be accomplished is studied in direct connection with the means, and altogether independently of any hampering prejudices. It is engineer's work well done, in a thoroughly workmanlike manner. But, the engineer's work appears to cease when the motive power and its mechanism is completed, just as the work of the engineer, in Europe, at least, ceased with the running gear of the railway carriage, and the completion of the vehicle is left to the conservatism, prejudice and convenience of the carriage builder, who has proved himself altogether unequal to the task which should have been his greatest opportunity. Instead of attacking the problem directly and definitely, as there was every opportunity for him to do, he calmly went ahead and placed upon the self-propelling mechanism, so ingeniously designed for him by the engineer, the orthodox carriage-body, evolved from centuries of precedent of a totally different character.

A fair comparison of the proceeding would be found if the modern bicycle had been designed complete as to framework and driving gear and then sent to the harnessmaker and equipped with an exact counterpart of the saddle designed for use with the horse. The modern carriage bears every evidence of its evolution as a horse-drawn vehicle, and the advantages and possibilities in design which the absence of the horse permits appear as yet to be scarcely realized. The horse was in the way of a front entrance to the vehicle, so the user was compelled to climb in over the wheels at the side. Now that the horse is no longer there the carriage builder still requires the rider to climb over the wheels, between the mud-guards of horsey days, and to an elevation which the height of the horse's body formerly made necessary, while the dashboard, which was naturally required to keep the heels of the equine from throwing mud over the riders, bravely retains its place as an example of the survival of the unfit. Heavy upholstery, enameled leather, freakish outlines and all the inheritance of the harnessmaker's influence, appear in the design, or lack of design, of the body of most of the current automobiles, and the machines have a mongrel appearance which shows their mongrel origin.

We say most automobiles, for there are some creditable exceptions, but these rare cases are those in which the engineer has ignored the carriage builder *in toto*. Makers of horse-drawn vehicles ought not to be slow to perceive that the rapidly approaching automobile is destined to work a great change in their industry. If the horse is to go, his form of carriage must go with him, and if the carriage builder is to save anything from the wreck he must make haste to adapt his product to the new conditions before he finds his trade has departed to join that of the builder of the old-time stage coach.

The Isthmian Canal Commission.

THERE was manifest disappointment expressed in various quarters when it was learned that the commission to be appointed by the President in accordance with the act of Congress to investigate and report upon the most feasible and practical route across the Isthmus of Panama for a canal was to be composed of practically the same members as constituted the old commission. This whole subject is very fully discussed in a recent issue of *Engineering News*, from which some significant extracts may be made:

"The fact that the majority of the commission comprises five such able engineers as Messrs. Noble, Burr, Morison, Hains and Ernst is one on which the engineering profession and the nation is to be heartily congratulated. The appointment of Alfred Noble is especially worthy of commenda-

tion. There is probably no American engineer better fitted by talent, experience and reputation to undertake the responsibilities which will be placed upon this commission than Mr. Noble, and engineers throughout the country will recognize his appointment as one conspicuously appropriate."

Of the others, Messrs. Burr and Morison have made their reputations through their achievements as structural engineers, and have not had extended experience as hydraulic engineers, but at the same time their acknowledged eminence and broad ability should render them valuable members. Generals Ernst and Hains are both competent men, the former possessed of much experience on the Missouri and Mississippi River Commissions and the latter especially familiar with the Nicaragua problem.

Ex-Senator Pasco and Professor Emory R. Johnson are presumably placed upon the commission to look after the commercial and economic aspects of the problem, which form so large a feature of the subject.

The new commission will start on its work under much more favorable auspices than either of the two commissions which have preceded it, since both the Ludlow and the Walker commissions were limited in their scope to the investigation of the route of the Maritime Canal Company of Nicaragua. The adverse report of the Ludlow Commission, and modifications recommended by the Walker Commission have not strengthened the position of this company before the public, and as its charter will have expired before the next Congress assembles, this limited range of inquiry is not a matter of especial importance at the present time.

This feature being eliminated, the new commission will start on its work under favorable auspices. "The public sentiment in favor of Government construction, and against subsidies to or alliances with any private corporation, has now been made so evident that there will probably be little attempt to influence the action of the commission. Enough preliminary work has been done on all the proposed routes to greatly facilitate the commission's work and enable it to make a much broader study of the question than has been possible at any previous time. The public will await with interest the final conclusions."

American Locomotives for Foreign Railways.

THE development of the American locomotive-building industry is one which can only be appreciated by people of other countries when it invades either their own territory or their own markets. The extent to which foreign demands are being supplied by American builders is not always appreciated, and a recent article in *Engineering News* gives some information on this point which is worthy of extended notice.

The export of American locomotives is by no means a recent matter; on the contrary, American engines were sent abroad three-score years ago. The first English order for American engines was in 1840, when locomotives built by William Norris, of Philadelphia, were used on the Lickey incline of the Birmingham and Gloucester Railway, now a part of the Midland system, where they competed successfully with the Bury locomotives in local service. It was Joseph Harrison, Jr., of Philadelphia, also, who, trained in the Norris works, secured the contract for the equipment of the St. Petersburg and Moscow Railway and built for that road in Russia many engines of American design in the early forties. Baldwin engines were also sent abroad about the same time, but the home demand which followed absorbed the energies of American builders for a time, and it was not until after the war that any material exports took place. Since, then, however, many foreign orders have been filled and during the past 24 years about 3,940 locomotives have been built in the United States for export, representing a value of more than $36,000,000. For a time the foreign work represented but a small proportion of the total production, being in 1890 only about 7 per cent. of the entire number, but this has steadily increased, until in 1898 more than 30 per cent. of the total output of locomotives was for foreign account, these going to more than 30 different countries. Apart from any question as to the specific merits or otherwise of the engines, there are definite reasons for this

increase. At the present time the United States is the cheapest market in the world for the purchase of the raw materials from which a locomotive is made. Up to 1892 this was not the case, iron and steel costing more in America than in England, but now the conditions are reversed. Nominally labor is higher in the United States than in England, but in proportion to the output per man the labor cost of the product is lower in America, and while men receive higher wages they give proportionally more value.

Assuming, then, an equal product in both cases the American builder should be able to underbid his foreign competitor, and in many cases he is doing so.

In regard to differences of construction between the American locomotive builder and those of other countries, the variations which are observed are mainly those of local custom and usage rather than of fundamental importance. Many writers have treated this point as if there could be only one correct way to build a locomotive, and that to differ from this only true and correct model must be to stray from the straight and narrow path. As a matter of fact, the locomotives of nearly every country possess national characteristics which do not in the least affect the performance or efficiency, but which often strike the stranger as being peculiar.

It is certainly a mistake to assume that American locomotives built for foreign countries are all made after a cut-and-dried series of patterns, regardless of the work to be done or the fuel and water to be used. On the contrary, the details of design and the materials of construction are varied at all times to meet the requirements of the service. At the same time, in nearly every locomotive works the templates and patterns for every design are so carefully kept and recorded that any part can be reproduced upon order without delay, and all the modern processes of duplication are utilized to assist in the manufacture.

The growth in the foreign demand for American locomotives does not mean that there has been any falling off in English business in the same fields. On the contrary, the value of locomotives exported from Great Britain has increased from a little more than $4,000,000, in 1893, to nearly $7,500,000, in 1898. The fact is that at the present time locomotive builders all over the world, like most other manufacturers, are filled with orders up to the limit of their capacity. This condition, however, cannot be expected to last, and when the competition for orders comes during a time when there is not more than enough work to go around, the experience gained during the present conditions may assist in determining where the greater portion of the work will be placed.

The Flow of Water Through Valves.

In computing the flow of water through passages of various forms the question of frictional resistance is always an important factor, but while various formulas have been deduced for computing the retarding effect of friction in straight and curved pipes of various materials, very little information has been available regarding the obstructive action of the tortuous passages through which the water must flow in passing valves.

A number of interesting and valuable tests have recently been made under the direction of Professor W. T. Magruder, at the Ohio State University, and a paper based upon these tests has been read by him at the convention of the American Water Works Association and published in the *Engineering Record*, giving a summary of the information both in a graphical and a tabular form.

Most engineers have assumed that a gate valve will pass more water at a given pressure than will a globe valve of the same nominal size under like conditions, but this opinion has been formed from general principles and not upon exact data. An examination of drawings of the two kinds of valves will show that in a globe valve there are eleven distinct occasions for hydraulic losses, of which nine are enlargements or contractions, one is skin friction, and one the turning of the main direction of flow through 360°. In the case of the straight-way valve there are six changes of section, besides the skin friction.

In most valves the area of the valve orifice is not as large as the actual area of the pipe connected with it, and in many globe

and angle valves the disc does not rise enough to give the full value of even what opening there is.

The tests made at the Ohio State University were upon valves for pipes from three-eight-inch to one and one-half inches nominal diameter, and from the account given by Professor Magruder every precaution seems to have been taken to secure accurate results. The water was delivered from the pumps into a stand-pipe, so that the pressure could be accurately regulated and measured, and the discharge through each valve was carefully measured. For the larger valves the discharge was measured by means of weirs, while for the smaller sizes the water was delivered directly into tanks for measurement. The runs were 20 minutes in duration in each test, and all the apparatus was carefully calibrated in order that the corrections might be made.

The best idea of the behaviour of the various valves is obtained from the curves given with the paper, but some general conclusions deduced from the diagrams will also be of interest. The amounts of water passed under given conditions by the gate and angle valves tested were approximately double and one and one-half times, respectively, the amount of water passed by the globe valves of the same nominal size under exactly the same conditions. That is, a straight-way valve is twice as good as a globe valve, and an angle valve is one and one-half times as good. Taking as the efficiency of a valve the ratio of the actual discharge to the theoretical discharge through a frictionless pipe of the same area under the same conditions, we have a means of comparison of valves of different makes and styles which may be very convenient. The efficiency of a valve is not necessarily constant, and with valves of certain makes the efficiency of different sizes varies greatly. In some of the valves tested there was a pressure at which the maximum efficiency appeared, while for others the efficiency appeared to be the same at all pressures, and it seems to have been very definitely established that the better the quality of the valve the higher the efficiency.

As a result of these tests it would seem to be advisable to use a gate valve when the full capacity of the pipe is always desired, a globe valve being only used in a water line when excessive throttling of the quantity or pressure is immaterial. In the case of water distribution it appears that by the use of gate valves of the proper size, pressures one-quarter to one-half of those that would be needed with smaller valves would be sufficient. This may not hold true and exact with the large valves of city water works, but it doubtless does hold true with the smaller pumping plant and hydraulic elevator service of office buildings and the like.

The tests also show that there are many points about valves in which a slight modification would materially increase the efficiency with but slight increase in first cost and the introduction of a testing plant similar to that described by Professor Magruder should enable manufacturers to make a marked improvement in their product in this respect.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Journal of Science. *m.* New Haven, Conn.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Brick Builder. *m.* Boston, Mass.
Bridges. *m.* Chicago.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francis co.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Electrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita, *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, U.S.A.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *w.* New York
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mitthellungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna
Ores and Metals. *w* Denver, Colo.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Públicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, U. S. A.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, U. S. A.
Stahl und Eisen. *s-m.* Düsseldorf.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston.
Terrestrial Magnetism. *qr.* Cincinnati, O.
Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
Trans. Am. Ins. Electrical Eng. *m.* w York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Western Railway Club Pro, Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, U. S. A.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Expanded Metal.

Expanded Metal Construction at the Exposition (Le Métal Déployé à l'Exposition). With illustrations showing the manner in which expanded metal has been used in connection with reinforced concrete construction in several of the buildings of the Exposition of 1900. 1200 w. La Revue Technique—May 25, 1899. No. 28307 D.

Exposition.

The Buildings of the Paris Exposition. Jacques Boyer. Prof. Boyer's second paper describes with many handsome illustrations the structures now being erected on the banks of the Seine and on the Esplanade des Invalides. 3000 w. Engineering Magazine—July, 1899. No. 28387 B.

The International Exposition at Paris, 1900 (Die Weltausstellung, Paris, 1900). The first portion of a general description of the grounds and buildings of the exposition. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—June 10, 1899. No. 28322 D.

The Textile Building of the Exposition of 1900 (Palais des Fils, Tissus, et Vêtements au Champ de Mars). L. Bourdain. A general description of this important structure of the exposition, with plate of details, and scaffolds for erection. 4000 w. 1 plate. Génie Civil—May 13, 1899. No. 28300 D.

Fireproofing.

Fireproof Floor Construction in California. G. W. Percy. Illustrates and describes the methods employed in the Wells-Fargo Building in San Francisco, and the Stanford University Library. 1000 w. Eng Rec—June 17, 1899. No. 28163.

Fire Tests of Fireproof Construction by the British Fire Preventive Committee. An outline of the proposed work, describing the testing plant and giving regulations governing the tests. Also editorial. Ill. 5400 w. Eng News—June 8, 1899. No. 28024.

Floors.

Economy in Floor Construction. Corydon T. Purdy. Gives plans for the floors of a warehouse made to enable the owners to decide for themselves which would be most desirable. 500 w. Br Build—June, 1899. No. 28289 C.

Hospital.

The Public Hospitals of Styria (Der Oeffentlichen Krankenpflege in Steiermark). Dr. E. Kleinsasser. With plans and details of arrangement of a number of modern hospital buildings in the province of Styria, in Austria. 10000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—June, 1899. No. 28334 D.

Mortar.

See Civil Engineering, Materials.

Ornamental Iron.

See Mechanical Engineering, Foundries.

Skeleton Construction.

The Use of Stone in Skeleton Construction. E. McL. Long. On the present practice in constructing steel-frame buildings, and the wrong ideas due to the habits acquired when stone was the strength-giving material. 2800 w. Bridges—June, 1899. No. 28239 C.

Stable.

A Hospital Stable. Describes the veterinary stable at Cornell University, which is fitted for the treating of sick animals. 1700 w. Eng Rec—June 3, 1899. No. 27976.

Structural Design.

Some Features of the Structural Design of Buildings. William H. Burr. Part first considers the need of the most advanced engineering principles in the construction of modern high buildings, and discusses foundations, metal frame-work, need of wind-bracing, etc. 14800 w. Jour Fr Inst—June, 1899. Serial. 1st part. No 27978 D.

HEATING AND VENTILATION.

Air Velocity.

Measurement of the Velocity of Air. R. C. Carpenter. Illustrates and describes some of the instruments and methods used, showing the difficulty in obtaining accuracy. 1500 w. Heat & Ven—June, 1899. No. 28292.

Exhaust Steam.

Exhaust Steam Central Heating Plant at Erie, Pa. Plans and information in regard to this installation for utilizing the exhaust steam of the electric railway and electric lighting stations. 700 w. Heat & Ven—May, 1899. No. 28018.

Hot Blast.

Design of Hot Blast Coils. Explains the methods of figuring coils for any given amount of work. 400 w. Eng Rec—June 3, 1899. No. 27975.

Jail.

The Ventilation of a Newark Jail. Illustrated description of a direct-indirect heating system with ventilation by means of a roof exhaust fan. 700 w. Eng Rec—June 10, 1899. No. 28078.

Radiators.

Air in Radiators. J. H. Kinealy. Explains why air gives trouble and the devices used to free the radiator but gives no solution of the problem. 1800 w. Heat & Ven—June, 1899. No. 28291

Residence.

Some Engineering Features of a Philadelphia Residence. Illustrates an unusually complete ventilating and heating system and electric lighting plant. 3500 w. Eng Rec—June 17, 1899. No. 28165.

Tests.

Test of a Blowing Fan in Connection with a Heating Coil. R. C. Carpenter. Describes tests made to investigate the capacity and efficiency of one form of heating surface in connection with a blowing fan. 2400 w. Heat & Ven—May, 1899. Serial. 1st part. No. 28019.

PLUMBING AND GAS FITTING.

Early Plumbing.

Plumbing and Lead Work in the Olden Time. Paul Plimton. Part first considers the early use of lead pipe in water supply. 1200 w. San Plumb—June 1. 1899. Serial. 1st part. No. 28017.

Fittings.

See Gas Engineering.

Gas Pipes.

Gas Pipe Engineering. Gives points on the inspection and remedying of defects. Ill. 1300 w. Am Gas Light Jour—June 19, 1899. No. 28149.

Master Plumbers.

The Position of the Master Plumber as Regards the Sewerage of Cities and Towns. James F. Traynor. Read at convention of the N. A. M. P. at New Orleans. Discusses the influence of the plumber in relation to the public health. 2400 w. Dom Engng—June, 1899. No. 28198 C.

Office Building.

Plumbing in the Empire Building, New York. Illustrated description of the numerous novel devices employed in plumbing a 21-story, 224 x 78 ft. office building. 3000 w. Eng Rec—June 24, 1899. No. 28235.

Piping.

See Gas Engineering.

Yacht Plumbing.

See Marine and Naval Engineering.

MISCELLANY.

Mechanical Influence.

Mechanical Influence in Architecture. G. W. Percy. The writer claims that the most influential factor in perfecting architectural forms has been purely mechanical, in devising the best methods of employing the materials, and the means used to overcome structural difficulties. 7700 w. Jour Assn of Engng Socs—April, 1899. No. 27013 C.

Moving Buildings.

See Civil Engineering, Miscellany.

CIVIL ENGINEERING

BRIDGES.

Arch.

The Bellefield Arch Bridge in Schenley Park, Pittsburg, Pa. Illustrated description of the construction of a handsome stone arch of 150 ft. span. 2000 w. Eng News—June 22, 1899. No. 28211.

The Kaiser Wilhelm Bridge. Illustrated description of the design and method of erection. Span, 525 ft.; total height, 350 ft. 4000 w. Eng Rec—June 10, 1899. No. 28071.

Atbara.

The Atbara River Bridge. Comment on the object lesson taught to British makers by the contract for this bridge, which was given to an American firm, discussing the causes and giving a brief history of the work. 2200 w. Engng—June 9, 1899. Serial. 1st part. No. 28180 A.

Concrete Construction.

Concrete in Railway Bridge Construction. H. W. Parkhurst. An illustrated critical review of the bridges on the Illinois Central System, with comment on the economy and usefulness of concrete construction, and a statement of the general principles of good concrete. 5500 w. Bridges—June, 1899. No. 28241 C.

Failure.

A Curious Railway Trestle Bridge Failure. Brief illustrated description of the collapse of a timber trestle under an ore train on the Belt Line branch of the Great Northern Railway, near Superior, Wis. 600 w. Eng. News—June 15, 1899. No. 28103.

India.

Bridges in India. Information relating to the work of F. E. Robertson and the recent bridge structures in India. Ill. 2700 w. Bridges—June, 1899. No. 28240 C.

Kornhaus Bridge.

Construction of the Kornhaus Bridge

Berne, Switzerland. Illustrated description of the details and methods of construction. This is a steel bridge of six arch spans, the largest of 377 feet. 2500 w. Eng Rec—June 17, 1899. No. 28156.

Lift Bridge.

The Morison Lift Bridge Over the Chicago River. Illustrates and describes a special design of bascule bridge, differing from other bascule bridges mainly in the driving machinery and the method of counter weighting. 600 w. R P Gaz—June 2, 1899. No. 27938.

Renewal.

Renewal of the Swing Bridge at Grahamstown, N. B. An illustrated account of the removal of a hand-power single-line swing bridge, and replacing it by a double-line swing bridge worked by hydraulic machinery. 1800 w. Transport—May 26, 1899. No. 27994 A.

Rhine.

The New Bridges Over the Rhine (Les Nouveaux Ponts sur le Rhin). H. Martin. A very fully illustrated account of the new bridges across the Rhine at Bonn and at Dusseldorf. Two articles. 1 plate. 5000 w. Le Génie Civil—May 20, 27, 1899. No. 28301 each D.

Richmond, Ind.

Bridges Over the Whitewater River at Richmond, Ind. Illustrates and describes a number of interesting structures. 600 w. Eng News—June 22, 1899. No. 28209.

Short Spans.

Some Short Span Railway Bridges. Illustrates two bridges on the Chicago and Northwestern Railway having unusually shallow floors and special details in connections. 1600 w. Eng Rec—June 3, 1899. Serial. 1st part. No. 27969.

Viaduct.

The Manhattan Valley Viaduct, New York City. Illustrated detailed description of the viaduct to carry the extension of Riverside Drive, from 127th street to 135th street, in New York. 1900 w. Eng News—June 8, 1899. No. 28023.

CONSTRUCTION.

Military Work.

I. Work and Experiences of the 1st Battalion, 1st Regiment, U. S. Volunteer Engineers, in Porto Rico. John Stephen Sewell. II. Work of the Third Regiment, U. S. Volunteer Engineers, in Cuba. Lyle F. Bellinger. Two letters describing work actually performed. 5400 w. Eng News—June 22, 1899. No. 28215.

Park Work.

Park Work at the Orchard Knob Battle Field. Describes the methods followed in building streets and gutters, ornamental walls, surface drains, etc. 1500 w. Eng Rec—June 24, 1899. No. 28232.

Pipes.

Laying Submerged Pipes. Part first gives an illustrated description of various methods which have been adopted in executing such work. Eng Rec—June 24, 1899. Serial. 1st part. No. 28228.

Roads.

Road Construction at Geneva, N. Y. Describes the manner in which an 8,000 population town is working out its good-roads problem. 1000 w. Eng Rec—June 24, 1899. No. 28231.

Road Making in Ontario. Gives the results of the recent attempts to improve the roads of the province, and the methods which seem most promising in securing better highways without prohibitive expense. 1700 w. Eng Rec—June 10, 1899. No. 28074.

The Development of Roads and Street Pavements. Francis W. Blackford. Describes ancient and modern road construction, and the various forms of paving, favoring properly constructed wooden blocks and asphalt pavings. 5800 w. Jour Assn of Engng Socs—April, 1899. No. 27915 C.

Tunnels.

The Boring of the Simplon Tunnel. (Die Durchbohrung des Simplon). H. Claus. A very complete description of the inception, progress and present state of this work, with sketch map and sections of the tunnel. 7000 w. Glaser's Annalen—May 15, 1899. No. 28347 D.

The Proposed East River Tunnel. Brief account with illustrations of the tunnel proposed by the Long Island Railroad Co., with references also to other projects. 1200 w. Sci Am—July 1, 1899. No. 28296.

HYDRAULIC AND MARINE.

Breakwaters.

Notes on the Effects of Waves on Breakwaters in Different Depths of Water. William Shield. Read at the Engineering Conference of the Inst. of Civil Engs., England. A study of wave action, comparing facts and theories. 2000 w. Engr, Lond—June 16, 1899. No. 28253 A.

The Design of Breakwaters. J. Watt Sandeman. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Considers the facts that determine the general character, position and principal proportions. 2200 w. Engr, Lond—June 16, 1899. No. 28254 A.

Calcutta.

The Port of Calcutta. Charles Cecil Stevens. Descriptive, with an account of

the harbor improvements and topics relevant to the subject. Discussion. 17200 w. Jour Soc of Arts—June 16, 1899. No. 28244 A.

Canals.

The Marseilles-Rhône Canal. (Le Canal de Marseille au Rhône). G. Leugny. A discussion both of the economic and engineering features of the proposed canal, with map of the route and sections at various points. 3000 w. La Revue Technique—May 25, 1899. No. 28308 D.

The New Trans-Isthmian Canal Commission. Editorial comment on the members of the commission and outline of the recent history of the project. 2500 w. Eng News—June 15, 1899. No. 28107.

The Report of the Nicaragua Canal Commission. Briefly compares the various reports, and shows the limited nature of investigations hitherto authorized by Congress, as compared with that ordered in 1809. 1500 w. Eng Rec—June 10, 1899. No. 28070.

Chambly.

The Hydraulic Features of the Chambly Water Power. Illustrated description of the dam and water-wheel plant of a large station on the Richelieu River, near Montreal. 700 w. Eng Rec—June 17, 1899. No. 28157.

Conduit.

Conduit of Sheet Steel. (Conduite en Tole d'Acier). A description of a steel conduit 2.4 metres in diameter spanning the River Arc in the form of an arch of 50 metres span. The computations are also given for a similar structure of reinforced concrete. 1200 w. La Revue Technique—June 10, 1899. No. 28313 D.

Dams.

Partial Failure of the Timber Crib Dam of the Montana Power Company, near Butte, Montana. M. S. Parker. Gives a general description and details of the causes of the partial failure, with the object of calling engineers' attention to elements to be guarded against in the construction of such dams, and the precautions necessary. Ill. 9000 w. Jour Assn of Engng Socs—April, 1899. No. 27916 C.

The Construction of a Crib Dam for the Butte City Water Co. Eugene Carrol. A description of the construction, with reasons for the adoption of the design. Short discussion. Ill. 3000 w. Jour Assn of Engng Socs—April, 1899. No. 27917 C.

Drainage.

State Drainage Work in the Red River Valley, Minnesota. Information from the last biennial report of the State Drainage Commission, stating the conditions and the success. 1000 w. Eng News—June 15, 1899. No. 28108.

Dredgers.

Sand Pump Dredgers. Anthony Geo. Lyster. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Information of the work on the Mersey Bar by dredging, especially since 1893. 1400 w. Engng—June 16, 1899 No. 28272 A.

Dry Dock.

The Dry Dock of Talcahuano, Chile (Das Trockendock von Talcahuano, Chile). A detailed account of this fine masonry dock, with map of the Bay of Concepcion, and drawings of the masonry construction and gates. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 19, 1899. No. 28328 B.

Flow.

The Flow of Water. Editorial discussing Prof. Hele-Shaw's experimental method of studying the flow of a perfect liquid. 2000 w. Eng Rec—June 24, 1899. No. 28227.

The Motion of a Perfect Liquid. A. S. Hele-Shaw. An illustrated study of stream lines and the behavior of liquids. 7000 w. Engr. Lond—June 2, 1899. No. 28299 A.

Index.

The Colton Index to Hydraulics. Describes a card index of literature on the whole field of hydraulic engineering, now preserved at Yale University. It illustrates the usefulness of this system when applied to one subject. 1200 w. Eng Rec—June 17, 1899. No. 28162.

Irrigation.

Irrigation in Mexico. An account of proposed undertakings which will undoubtedly be of great benefit to the country. 1100 w. U. S. Cons. Repts, No. 451—June 14, 1899. No. 28099 D.

Lock.

The Hotopp System of Locks for the Elbe-Trave Canal (Die Hotoppschen Betriebseinrichtungen der Schleusen des Elbe-Trave-Kanals). H. Arnold. With plans and sections of the lock and a description of its operation. 2500 w. Zeitschr d Ver Deutscher Ing—May 27, 1899. No. 28320 D.

Porto Rico.

The Engineering Development of Porto Rico. Herbert M. Wilson. A review of the commercial engineering possibilities of the island, with especial regard to the utilization of the numerous water powers available. 4000 w. Engineering Magazine—July, 1899. No. 28384 B.

Stave Pipe.

Stave Pipe; Its Economic Design and

Use. Arthur L. Adams. A discussion, with illustrations, of the essential considerations in stave-pipe design, and some of the limitations imposed; with a study of existing lines, and a comparison with leading types of large pressure pipes. 10900 w. Jour N E Water Wks Assn—June, 1899 No. 28110 E.

Water-Pipe.

Improved Wyckoff Water-Pipe. Geo. L. Wells. Gives a brief description of this pipe and its manufacture, discussing details. Ill. 5400 w. Jour N E Water Wks Assn—June, 1899. No. 28111 E.

The Use of Steel for Water Mains. L. M. Hastings. States the few conditions and situations where steel seems best adapted for use, and the principal advantages, discussing cost, protective coating, durability, etc. 3000 w. Jour N E Water Wks Assn—June, 1899. No. 28113 E.

Water Pipes on Metropolitan Water Works. Dexter Brackett. Brief account of the pipes made of steel plates used in Boston. 2500 w. Jour N E Water Wks Assn—June, 1899. No. 28114 E.

MATERIALS.

Asphalt.

Residuum as Flux for Asphalt. Clifford Richardson. A criticism of statements made by A. W. Dow in his annual report, with results of experiments made by the writer. 800 w. Munic Engng—June, 1899. No. 27918 C.

Cement.

Cement and Cement Testing. Robert W. Lesley. The paper aims to give, both from the manufacturer's and engineer's points of view, some idea of the various specifications that have to be met in the use of cement, the difficulties in the testing, and of the machinery, with some description of the laboratories in this country and in Europe. Ill. 8000 w. Pro Engs' Club of Phila—May, 1899. No. 27910 D.

Concrete.

Concrete for Street Work. Describes the construction of concrete curbs, sidewalks and streets in Iowa. 1500 w. Eng Rec—June 3, 1899. No. 27971.

On the Theory of Concrete. George W. Rafter. Results of tests made by the author, with details of the work. 2000 w. Pro Am Soc of Civ Engs—April, 1899. No. 28118 E.

Mortar.

Sand for Mortar. Ira O. Baker. The importance of the quality on the strength and durability of the mortar is shown, and the requirements of a good building sand are discussed. 2500 w. Br Build—June, 1899. No. 28288 C.

Reinforced Cement.

The Development of Reinforced Cement Construction (Evolutions des Constructions en Ciment Armé). A brief review of the various systems of strengthening cement and concrete work with embedded metal. 2000 w. La Revue Technique—June 10, 1899. No. 28312 D.

Testing Laboratory.

A Few Remarks on the Testing Laboratory of the City of Philadelphia. Richard L. Humphrey. Describes recent additions in the equipment of the laboratory, and gives some results of tests which have been made. Discussion. Ill. 4500 w. Pro Engs' Club of Phila—May, 1899. No. 27911 D.

Volcanic Products.

The Utilization of Volcanic Products. Discusses this new material being introduced for use of dock and railway contractors, builders, etc. Basalt, lava stone, and trass. 3500 w. Engr, Lond—May 26, 1899. No. 28013 A.

MEASUREMENT.

Surveys.

Surveys in Tropical Forests. From a paper by Frederic Shelford, recently contributed to the Institution of Civil Engs. Describes methods employed in Africa and Central and South America. 2000 w. Eng Rec—June 3, 1899. No. 27973.

Transition Curves.

Laying Down Transition Curves by Offsets. Shows a transition curve based upon the cubic parabola, and describes the method of laying it out. 700 w. Eng News—June 22, 1899. No. 28213.

Triangulation.

The Invention of Triangulation. (Die Erfindung der Triangulirung). S. Welisch. An examination into the history of modern surveying, showing the earliest use of triangulation to have been by Augustin Hirschvogel, in 1547, at Vienna. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—May 19, 1899. No. 28329 B.

MUNICIPAL.

Bathing Plant.

Boston's Free Municipal Bathing Plant. J. A. Stewart. Illustrated detailed description. 1200 w. Sci Am Sup—June 24, 1899. No. 28202.

Filtration.

The Operation of Water Filters in Germany. Translation of the official regulations for the operation of sand filters during times of cholera which are also advised for regular service. 1600 w. Eng Rec—June 10, 1899. No. 28076.

The Slow Sand Filtration Plant for

Little Falls, N. Y. Describes a plant containing some unique features, now being built for the city named. 1600 w. Eng News—June 22, 1899. No. 28212.

Fire Protection.

Salt Water Fire System of Boston. Frank A. McInnes. Describes the system which aims to extend the action of the fire boats, so that the power may be available at a distance from the water front. Ill. 2700 w. Jour N E Water Wks Assn—June, 1899. No. 28112 E.

The City's Fire Hydrants, Water Pressure and Meters. Information brought out in the testimony at the Mazet investigation. 2500 w. Fire & Water—June 10, 1899. No. 28069.

Water Curtains for the Fire Protection of the Chicago Public Library. Illustrates and describes the system. 1100 w. Eng News—June 8, 1899 No. 28025.

Flood Water.

The Use of Filtered Flood Water. M. W. Hervey. Read at the Engineering Conference of the Inst. of Civ. Engs., England. Discusses the flood waters of the rivers Thames and Lea. 1500 w. Engr, Lond—June 16, 1899. No. 28256 A.

Kansas City.

Public Works in Kansas City. Describes recent street work, trouble with smoke, and the reconstruction of a reservoir with partially fallen walls. 900 w. Eng Rec—June 17, 1899. No. 28160.

Porto Rico.

A Porto Rican Well. Illustrates a well having a brick curb 7 to 9 feet in diameter and considerably over 100 feet deep. 600 w. Eng Rec—June 17, 1899. No. 28158.

Refuse.

Refuse Disposal in New York in 1898. Describes the experience with garbage reduction and cremation in the various boroughs, and gives the cost of sorting salable refuse. 1100 w. Eng Rec—June 10, 1899. No. 28073.

Reservoirs.

A Great Excavation and Embankment Contract. Gives a summary of the important requirements for clearing most of the Wachusett reservoir basin. 1200 w. Eng Rec—June 10, 1899. No. 28075.

Recent Reservoir Linings. Illustrated account of the methods followed at Black Hawk, Col., and Coatsville, Pa., in laying brick and asphalt linings, and at Lancaster, Ohio, with a concrete and brick lining. 1000 w. Eng Rec—June 24, 1899. No. 28233.

Sewage Disposal.

Notes on the Berlin Sewage Farms. James H. Fuertes. Illustrated article on details of these farms not before made public. 600 w. Eng Rec—June 10, 1899. No. 28072.

Sewage Sludge Disposal by Natural Agencies. G. Sims Woodhead. Read at the Engineering Conference of the Inst. of Civ. Engs., England. Brief notes on the treatment of solid matter in sewage. 1100 w. Engr, Lond—June 16, 1899. No. 28258 A.

The Purification of the Thames, England. Gives the results which have followed the chemical clarification of London sewage. 2000 w. Eng Rec—June 17, 1899. No. 28161.

Sewer Pipe.

Sewer Pipe; Its Manufacture. A complete account of the process, including water smoking, heating up, vitrifying, salting and cooling. 4300 w. Brick—June 1, 1899. No. 28030.

Sewers.

A Constant Flow Sewer Regulator. Illustrated description of apparatus used to maintain a constant flow from a branch sewer into an intercreptor, no matter what the height of water in the latter. 350 w. Eng Rec—June 24, 1899. No. 28229.

A New Method of Ventilating Sewers. Charles Cameron. Read at a meeting of the Royal Inst. of Archts. of Ireland, May 25, 1899. Describes a sewer diffuser ventilator, which has given satisfaction in Dublin. 1300 w. Builder—June 17, 1899. No. 28245 A.

Sewer Construction and Maintenance. Report of a discussion in which the views of a number of New England engineers were given. 3500 w. Eng Rec—June 24, 1899. No. 28230.

The Sewerage of London, England. History of the works and a statement of their size and effect on the Thames. 3500 w. Eng Rec—June 3, 1899. No. 27977.

Sterilization.

See Electrical Engineering, Electrochemistry.

Substructures.

The Economic Arrangement and Construction of Sub-Structures in Streets. H. C. Hodgkins. Read at Columbus, Ohio, convention of the Am. Water Works Assn. Advocates the building of subways under the sidewalks, showing that the plan has much in its favor. 3200 w. Fire & Water—June 24, 1899. No. 28242.

Subways.

Subways for Street Pipes. Abstract of a paper by H. C. Hodgkins before the Am. Water Works Assn. advocating subways under sidewalks. 1400 w. Eng Rec—June 3, 1899. No. 27974.

Water Analysis.

The Saline Constituents of Water from the Chalk. J. C. Thresh. Read before the British Assn. of Water Works Engs. On the importance of a systematic record being kept of the analyses and other information concerning water supplies. Gives analyses of chalk waters. Discussion. 4000 w. Jour Gas Lgt—June 13, 1899. No. 28194 A.

Water Main.

Cleaning a Water Main in St. John, N. B. William Murdoch. Describes the process used and reports the improvement in pressure and satisfactory results. 3000 w. Jour N E Water Works Assn—June, 1899. No. 28115 E.

Water Meters.

The Results of the Meter System in Richmond, Va. A description, with diagram, of the effect of meters on the pressure in street pipes. 900 w. Eng. Rec—June 3, 1899. No. 27972.

Water Supply.

A Consideration of the Rate per Head per Day of Supply in Different Towns, and the Causes Which Increase or Diminish It in Particular Instances. James Watson. Read at the Engineering Conference of the Inst. of Civ. Engs., England. Discusses some of the more important causes. 1500 w. Engr, Lond—June 16, 1899. No. 28257 A.

London Water Supply. Tables and diagrams showing the rainfall at Greenwich, and a discussion of the sources of supply and the effect of dry weather. 2000 w. Engr, Lond—May 19, 1899. No. 27902 A.

Water Supply of Philadelphia. Communications from John C. Trautwine, Jr., and Edgar Marburg, presented at a special meeting held March 25, 1899, to discuss the present problem of the water supply. Also general discussion by Messrs. Hicks, Schermerhorn and Fuller. 5000 w. Pro Engs' Club of Phila—May, 1899. No. 27912 D.

Water-Works.

A Lesson in Water-Works Management. An account of the partial wreck of a water-works by incompetent management. 900 w. Eng Rec—June 17, 1899. No. 28159.

The Waterworks of Bergisch-Gladbach. (Das Wasserwerk der Stadt Bergisch-Gladbach). H. Ehlert. An illustrated description of the plant by which a town of 10,000 inhabitants is supplied from ground-water sources. 5000 w. Zeitschr d Ver Deutscher Ing—June 17, 1899. No. 28326 D.

The Water-Works of Columbus, Ohio. Illustrated description of one of the largest plants in the United States drawing water from filter conduits. 3600 w. Eng Rec—June 3, 1899. No. 27970.

Water-Works in Russian Cities. Translation of the specifications for the proposed works for the city of Nicolaiev, Russia. 1300 w. U. S. Cons. Repts, No. 450—June 13, 1899. No. 28097 D.

MISCELLANY.

Afghanistan.

Engineering in Afghanistan. Reviews the work accomplished and the mechanical progress which has been made in Kabul. 1700 w. Ind & East Engr—May, 1899. No. 28096 D.

Moving Buildings.

Raising and Moving Large Buildings. Illustrates and describes two pieces of difficult work. The first, the removal of the town hall at Washington, Pa.; the second, the reconstruction of the lower portion of the Mandel Building, Chicago. 1000 w. Eng News—June 1, 1899. No. 27929.

Santiago.

Engineering Notes at Santiago de Cuba. H. M. W. Describes the topography, and gives information concerning the sanitary condition, water supply, streets, harbor, etc. 3500 w. Eng News—June 8, 1899. No. 28026.

ELECTRICAL ENGINEERING

COMMUNICATION.

China.

Electrical Notes in China. Francis B. Crocker. Part first discusses the development of the telegraph and the difficulties arising from the hostility of the natives. Describes the process of sending a Chinese telegram. 1500 w. Elec Wld & Elec Eng—June 17, 1899. Serial. 1st part. No. 28124.

Coherer.

The Substitution of Magnetic for Mechanical Action in a Coherer (Sur la Substitution de l'Action Mágnétique a l'Action Mécanique du Trembleur). Th. Tommasina. A communication to the French Academy showing how the mechanical tapping for de-cohering may be advantageously replaced by the action of a magnet. 500 w. L'Electricien—June 10, 1899. No. 28375 B.

Earth Currents.

Atlantic Earth Currents. F. Raymond-Barker. An interesting record of earth-

current observations made by the writer on a submarine cable. 700 w. Elec Rev, Lond—June 9, 1899. No. 28177 A.

Interconnecting.

Switchboard Operator's Interconnecting Equipments. H. P. Clausen. Discusses the means that may be devised for connecting together and controlling the switchboard terminals of two or more centralized telephone circuits. Ill. 3000 w. Elec Engng—June, 1899. Serial. 1st part. No. 28219.

Space Telegraphy.

Experiments with Wireless or Space Telegraphy. Dr. I. Kitsee. Describes a series of experimental tests and gives the deductions drawn from them, and the practical applications possible, describing an arrangement that it is believed will effectually prevent collisions on steam roads. 2500 w. Elec Wld & Elec Engr—June 24, 1899. No. 28217.

On Wireless Telegraphy. A. S. Dolbear. Recalls some early experiences with the telephone which were explained as due to induction, reviews experiments of Prof. Trowbridge, made in 1880, and also of others, calling attention to the distinction between conduction and induction. 2500 w. Elec Wld & Elec Engr—June 10, 1899. No. 28060.

The Experiments of Prof Hughes on Ether Telegraphy. J. Munro. An account of the original experiments of Prof. Hughes, showing that he discovered all the elements of wireless telegraphy as now known, nearly twenty years ago. 2200 w. Elec Rev, Lond—June 2, 1899. No. 28083 A.

Telegraphs.

An Imperial Telegraph System. J. Henniker Heaton. Considers the high charges for telegrams to all parts of the British Empire, proposes a remedy, and discusses the scheme. 3500 w. Nineteenth Cent—June, 1899. No 28153 D.

Telegraph Lines.

Construction and Reconstruction of Telegraph Lines. C. H. Bristol. Condensed paper, read before the Assoc. of Ry. Telegraph Supts. at Wilmington, N. C. Reviews recent improvements in this work, describing the most approved construction. 1800 w. R R Gaz—June 2, 1899. No. 27939.

Telephones.

Germain's Loud-Speaking Telephone. L. Leroy, in *La Nature*. Illustrated description of the instrument. 800 w. Sci Am Sup—June 3, 1899. No. 27943.

Some Problems in Telephone Engineering. Theodore Spencer. Briefly outlines the general system of telephone lines as now used, discussing a few prominent details, and stating the problem as it appears at present, and some possible methods of solving the difficulties. Ill. 3800 w. Pro Engs' Club of Phila—May, 1899. No. 27909 D.

Telephone Relays or Repeaters. William J. Hammer. Describes experiments, giving an analysis of the scientific phenomena connected with them. Ill. 2300 w. Elec Wld & Elec Engr—June 3, 1899. No. 27982.

Telephone Repairs.

Minor Telephone Troubles and How to Correct Them. H. P. Clausen. A general discussion of telephone repairs. 2000 w. W. Electr'n—June 24, 1899. No. 28243.

DISTRIBUTION.

Alternating Currents.

Three-Phase Four-Wire Low-Tension Systems. A. J. Bowie, Jr. Describes a plant of this kind and tests made on it. 2400 w. Elec Wld & Elec Engr—June 17, 1899. No. 28123.

Arresters.

Lightning Arresters for Electric Conductors (Les Parafoudres sur les Canalisations Electriques). M. Bochet. A paper read before the *Societe Internationale des Electriciens*, with illustrations of various forms of arresters. 7500 w. Bull de la Soc Int des Electriciens—April, 1899. No. 28367 F.

Construction.

Underground Electrical Construction. L. A. Ferguson. Abstract of a paper read at the recent convention of the Nat. Elec. Lgt. Assn., in New York. Part first describes the Edison tube for feeders. 1400 w. Elec Wld & Elec Engr—June 24, 1899. Serial. 1st part. No. 28218.

Converter.

The Rotary Converter. E. W. Rice, Jr. Sketches the development of the more important systems of distribution and reviews their present standing, showing the necessity for some practical connecting link, which is found in the converter. 8000 w. Sib Jour of Engng—June, 1899. No. 28126 C.

Polyphase System.

A New System of Polyphase Generation. Concerning the system developed by C. P. Steinmetz, considering some of the direct applications of the principle suggested. Ill. 2000 w. Elect'n, Lond—June 9, 1899. No. 28175 A.

Regulations.

Safety Regulations for Electric Currents of Moderate Pressure (Sicherheitsvorschriften für Elektrische Mittelspannungs-Anlagen). The full text of the

regulations reported by the committee of the German Electrotechnical Society for use in connection with currents of pressures between 250 and 1000 volts. 6000 w. Elektrotech Zeitcshr—May 18, 1899. No. 28355 B.

Safe Methods.

Means of Attaining Safety in Electrical Distribution. W. L. R. Emmet. Read before the Nat. Elec. Assn at New York. Considers the principal sources of danger and considers methods for securing safety. Ill. 3300 w. W Elect'n—June 3, 1899. No. 28022.

Single-Phase.

Single-Phase Distribution of Electric Current. Herbert A. Wagner. Abstract of a paper read before the Nat. Elec. Lgt. Assn., New York. Describes the results obtained by the Missouri-Edison Electric Co., of St. Louis. 1900 w. Eng News—June 1, 1899. No. 27931.

Underground.

Some Notes on Underground Distribution of Two-phase Currents in New York City. E. A. Leslie. Abstract of paper read before the Nat. Elec. Lgt. Assn. Describes the system and explains why it was adopted; gives the method of testing for faults, testing insulation resistance of the line circuits, etc. 2400 w. Elec Wld & Elec Engr—June 17, 1899. No. 28125.

Wiring.

A Universal Electric Wiring Chart. Sanford H. Fry. Chart and formula for solving problems pertaining to electric wiring for the transmission of energy. 700 w. Am Mach—June 22, 1899. No. 28197.

The Computations of a Wiring System for Incandescent Lamps (Calcul d'une Canalisation Electrique pour Lampes à Incandescence). A. Vallée. A mathematical computation, taking into account leakage, heating, economy of copper, and the various elements which enter in practical work. Three papers. 2500 w. L'Electricien—May 6, 13, 20, 1899. No. 28369 each B.

ELECTRO-CHEMISTRY.

Accumulators.

The Elot Accumulator (Der Akkumulator Blot). Showing the details of the lead band construction and giving data and results of tests. 2500 w. Elektrochemisch Zeitschr—June, 1899. No. 28366 H.

Notes on the Theory of the Lead Accumulator (Beiträge des Blei-Akkumulators.) F. Dolezalek. A mathematical discussion, taking into account the degree of concentration of the acid solution and its effect upon the electromotive force. 3000 w. Zeitschr f Elektrochemie—May 25, 1899 No. 28364 H.

Storage Batteries. E. L. Nichols. Reviews the processes of Faure and Planté for the production of the plates, modifications of the grid, etc., noting the most important applications of the storage battery. 1600 w. Sib Jour of Engng—June, 1899. No. 28133 C.

Battery.

A New Primary Battery Cell of Large Capacity and high economy. From *Cosmos*. Illustrates and describes the Jeanty cell. 1200 w. Sci Am Sup—June 24, 1899. No. 28203.

Bleaching.

Electrical Bleaching (Elektrische Bleiche). Victor Engelhardt. A description of the process and apparatus used at the bleachery of Gebauer at Charlottenburg, with data of production and cost. 1000 w. Elektrochemische Zeitschr—May, 1899. No. 28365 H.

Chemical Reaction.

Dr. Tommasi "On the Law of the Proportionality of the Electromotive Force of Decomposition." Abstract of paper published in the *Bulletin Technique*. Gives experiments which the writer considers sufficient to disprove Berthelot's law of maximum work, and Sprague's law of minimum work, and formulates a new principle, termed the "principle of least work." 2200 w. Elec Rev, Lond—June 2, 1899. No. 28085 A.

Chlorate Works.

The Electrolytic Chlorate Works at Chedde, Savoy. John B. C. Kershaw. Facts showing the progress of the new method of manufacture, and giving an account of the works situated at Chedde, Haute Savoie, close to Chamounix. 2300 w. Eng & Min Jour—June 10, 1899. No. 28066.

Electro-Metallurgy.

Electro-Metallurgy as a Department of Electrical Engineering. R. H. Thurston. A review of the origin, progress, and present status of the art, illustrating its principles and practice by the aluminum industry. Sib Jour of Engng—June, 1899. No. 28131 C.

Sterilization.

The Sterilization of Potable Water (Sur la Sterilisation Industrielle des Eaux Potables). MM. Marmier and Abraham. A discussion of the experiments made at Lille upon the sterilization of water by ozone, with comments upon the official report. 1000 w. L'Electricien—June 3, 1899. No. 28374 B.

The Sterilization of Water (La Sterilisation de l'Eau). E. Andreoli. A criticism of the report of the Marmier and

Abraham ozone process as employed at Lille. 1200 w. L'Electricien—May 13, 1899. No. 28371 B.

ELECTRO-PHYSICS.

Interrupter.

The Wehnelt Electrolytic Interrupter. Ernest Merritt. A statement of some of the chief characteristics, with especial reference to its use. 1500 w. Sib Jour of Engng—June, 1899. No. 28132 C.

Theory.

Hydrodynamic Analogies to the Theory of Potential and Electrotechnics (Hydrodynamische Analogien zur Theorie des Potentials und der Elektrotechnik). Dr. Holzmüller. A comparison between the laws and phenomena of hydrodynamics and those of electricity, showing the close analogy. Two articles, 7000 w. Zeitschr d Ver Deutscher Ing—June 3, 10, 1899. No. 28321 each D.

Vector Diagrams.

The application of Vector Diagrams to the Flow of Alternating Currents (Ueber die Anwendung des Vektordiagramms Dr. F. Breisig. Devoted especially to the consideration of flow in long circuits with high tensions. Two articles, 9000 w. Elektrotech Zeitschr—June 1, 8, 1899. No. 28360 each B.

GENERATING STATIONS.

Barking, Eng.

Barking Electricity Works. Illustrated detailed description of the works, with history of the undertaking. 2800 w. Elec Eng, Lond—June 2, 1899. No. 28086 A.

Brooklyn Station.

The Development and Operation of a Local Electrical Transmission System. W. S. Barstow. Abstract of a paper read before the Nat. Elec. Lgt. Assn., New York. An account of the station of the Brooklyn Edison Electric Co., with the distribution and operation. 5000 w. Eng News—June 1, 1899. No. 27930.

Electric Supply.

The Newington Vestry Electric Supply Works. Illustrated detailed description, with historical account of this London plant. 2800 w. Elect'n, Lond—June 9, 1899. No. 28174 A.

Friction.

Friction Losses in Electrical Machinery (Die Reibungsverluste in Elektrischen Maschinen). G. Dettmar. A very complete investigation of journal friction in dynamos and motors taking into account the various temperatures and pressures. Two articles, 10000 w. Elektrotech Zeitschr—June 1, 8, 1899. No. 28359 each B.

Isolated Plant.

The Largest Isolated Electric Light Plant in the World. Illustrated description of the plant of the Waldorf-Astoria, in New York. 3200 w. Power—June, 1899. No. 27934.

Montmorency Falls.

Development of the Montmorency Falls. F. M. Archibald. Illustrates and describes the power plant and system of distribution. 4800 w. Elec Wld & Elec Engr—June 17, 1899. No. 28120.

Transformation.

Methods of Electrical Transformation. James Swinburne. Read before the British Inst. of Civ. Engs. Also discussion. Considers the various systems and the questions of copper and insulation. 2200 w. Elec Eng, Lond—June 9, 1899. No. 28168 A.

Transformers.

Transformers: Iron Loss—Its Increase—The Remedy. G. Wilbur Hubley. Read before the Nat. Elec. Lgt. Assn., New York. The writer has studied this subject carefully for several years and gives data, tests, etc., compiled from actual facts and conditions. 2200 w. Elec, N. Y.—June 7, 1899. No. 28044.

Watford, Eng.

Watford Municipal Electric Supply Works. Illustrates and describes these works, which possess several novel features. 2000 w. Elect'n, Lond—June 2, 1899. No. 28087 A.

HEATING AND WELDING.

Rail Welding.

The Present Status of Electric Welding of Rails. H. F. A. Kleinschmidt. Describes the excellent results obtained by the Lorain Steel Co., by making a weld from a boss on a bar, instead of from a flat bar. 1000 w. St Ry Jour—June, 1899. No. 27949 D.

LIGHTING.

Nernst.

The Nernst Incandescent Lamp (Die Nernstsche Glühlampe). An abstract of an address recently delivered by Prof. Nernst, giving details concerning the construction and performance of his new incandescent lamp. 1500 w. Elektrotech Zeitschr—May 18, 1899. No. 28356 B.

The Nernst Lamp of the Allgemeinen Elektrizitäts-Gesellschaft, Berlin. (Die Nernst-lampe der Allgemeinen Elektrizitäts-Gesellschaft, Berlin). An address given by the inventor at a public exhibition of the Nernst lamp in Berlin, showing the importance of the invention

and the relation it bears to its predecessors. 2500 w. Glaser's Annalen—June 1, 1899. No. 28349 D.

Socket.

Standard Socket and Bayonet Fastening for Incandescent Lamps (Normalien für Glühlampenfüsse und Fassungen mit Bajonettkontakt). Abstract from the report of the committee of the German Electrotechnical Society, with drawing of the socket and fastening. 1000 w. Electrotech Zeitschr—May 11, 1899. No. 28352 B.

MEASUREMENT.

Alternating Currents.

Methods of Determining the Frequency of Alternating Currents. Carl Kinsley. Reviews methods that have been used and suggests a new and easy method that may be employed with an error of less than ¼ of 1 per cent. Ill. 1800 w. Elect'n, Lond—June 16, 1899. No. 28251 A.

Dynamo Testing.

A Simple Method of Testing Dynamos (Ueber eine Einfache Methode zur Prütung von Dynamomaschinen). J. Fischer-Hinnen. Giving equations to be used in computing the losses due to friction hysteresis, and eddy currents. 2000 w. Elektrotech Zeitschr—June 1, 1899. No. 28361 B.

Galvanometers.

M. Blondel's Oscillographs. Abstract of a paper read before L'Association Francaise pour L'Avancement des Sciences. Discusses the principles of construction and the theory of this class of galvanometers with which the forms of the periodic curves of alternating currents may be observed. 1700 w. Elec Rev, Lond—June 16, 1899. No. 28247 A.

High Potentials.

Some Methods of Measuring High Potentials with Low Potential Instruments. Samuel J. Barnett. Illustrates and describes two methods found to be useful. 900 w. Elec Wld & Elec Engr —June 17, 1899. No. 28122.

Insulation.

The Measurement of the Total Insulation of Accumulator Batteries. (Methode zur Messung der Gesammtisolation von Akkumulatoren Batterien). C. Liebenow. Two methods are given, one for ordinary use and the other when a high degree of insulation is required. A brief discussion is appended. 2000 w. Elektrotech Zeitschr—May 18, 1899. No. 28357 B.

Insulation Meter for Alternating Currents (Isolationsmesser für Wechselstrom-Betriebsspannung). Dr. Gustav Benischke. Illustrating and describing the convenient portable apparatus of the Allgemeine Elektricitäts Gesselschaft, and giving examples of its use. 2500 w. Elektrotech Zeitschr—June 8, 1899. No. 28363 B.

Meter.

Improved Electric Power Meter (Nouveau Compteur d'Energie Electrique). M. Aliamet. An illustrated description of the new Aron meter, with automatic electric regulator. Details of the mechanism are given. 2500 w. L' Electricien—June 3, 10, 1899. No. 28373 each B.

Some Non-Integrating Electric Meters. William Edward Ayrton. Read before the British Inst. of Civ. Engrs. Considers the construction of meters, the materials used, improvements in galvanometers, ammeters, voltmeters, etc. Short discussion. 2000 w. Elec Eng, Lond—June 9, 1899. No. 28169 A.

Tests.

Transformer Tests. W. Elwell Goldsborough. Abstract of a paper read before the Nat. Elec. Lgt. Assn., New York. Reports the results of a series of tests made at the electrical laboratories of Purdue University. Five different transformers were tested with gratifying results. 3700 w. Eng News—June 1, 1899. No. 27932.

POWER APPLICATIONS.

Electric Locomotives.

Electric Locomotive Design. Editorial discussion of the paper of P. V. McMahon, read before the London Inst. of Engs., London. 1700 w. Engng—May 26, 1899. No. 28000 A.

Electric Locomotives in Practice and Tractive Resistance in Tunnels. An Abridgment of a paper by P. V. Mc Mahon, read before the London Inst. of Elec. Engs. It is based on experiments made on the locomotives and trains of the City & South London Ry. 4700 w. St Ry Jour—June, 1899. No. 27953 D.

Electric Power.

See Mining & Metallurgy, Mining.

Electric Vehicles.

See Mechanical Engineering, Automomobilism.

Machine Driving.

The Application of Electric Motors to Machine Driving. Andrew Stewart. Part first considers the commercial possibilities of electric power. 900 w. Elec, Lond—June 2, 1899. Serial. 1st part. No. 28079 A.

Mining Power.

Electric Transmission and Electric Drills for Mines. F. Hille. Read before the Can. Min. Inst. Discusses long-distance transmission, the production of

electricity by some other medium than water and directly at the mines, the application to machine driving, and the advantage of the electric drill. Ill. 4000 w. Can Min Rev—May 31, 1899. No. 27-987 B.

Propulsion.

Electrical Propulsion for Torpedo Boats. W. F. Durand. Discusses the limitations and possibilities of electric propulsion, in connection with a review of data given in an article by C. T. Child, published recently in the Jour. of Am. Soc. of Nav. Engs. 4300 w. Sib Jour of Engng—June, 1899. No. 28130 C.

Subdivision.

The Limitations of Power Subdivision by Electric Motors in Manufacturing Establishments. A topical discussion considering economy of power, economy of cost, convenience, etc. 16800 w. Trans Am Inst of Elec Engs—April, 1899. No. 28285 D.

TRANSMISSION.

Kootenay.

The Kootenay-Rossland Power Transmission. George P. Low. Illustrated description of the region, the power development, and pole line, are given in part first. 3700 w. Jour of Elec—May, 1899. Serial. 1st part. No. 28236.

Long Distance.

Economical Transmission and Distribution of Electricity from a Distance. Horace Field Parshall. Read before the British Inst. of Civ. Engs. Considers the subject under economical generation, transmission and distribution. Short discussion. 2200 w. Elec Eng, Lond—June 9, 1899. No. 28172 A.

Polyphase.

Rotary Transformers and Storage Batteries as Related to Long-Distance Transmission. William Lispenard Robb. Read before the Nat. Elec. Lgt. Assn., New York. A description of the Hartford, Conn., plant and of its operation. Discussion. 3800 w. Elec, N. Y.—May 31, 1899. No. 27908.

Polyphase.

Relation Between Armature and Line Currents in Polyphase Transmission. Henry S. Carhart. Gives a graphical method for elucidating the relative phases and magnitudes of the currents flowing in adjacent connected circuits of a polyphase generator and in the line when the system is balanced. 800 w. Elec Wld & Elec Engr—June 17, 1899. No. 28121.

Three-Phase Power Transmission at St. Hyacinthe, Quebec, Canada. E. M. Archibald. Illustrated description of the oldest plant in Canada employing this system. 2200 w. Elec Wld & Elec Engr—June 24, 1899. No. 28216.

See Street and Electric Tramways.

MISCELLANY.

Insulation.

The Decay of Vulcanized Rubber. H. L. Terry. Discusses the cause of the decay, suggesting that it is the action of either the free or the combined sulphur in the copper. 2700 w. Elect'n, Lond—May 26, 1899. No. 27998 A.

"New" Rays.

Becquerel or Uranium Rays and Other "New" Rays and Their Relation to X-Rays. O. M. Stewart. An account of experimental work and the results. 1600 w. Sib Jour of Engng—June, 1899. No. 28134 C.

Rays.

Human Rays. Ottokar Hoffmann. An illustrated account of experiments seeming to show that the human body emits rays which act on a sensitive photographic plate. 1300 w. Eng & Min Jour—June 24, 1899. No. 28224.

Switzerland.

Electro-technical Excursion in Switzerland (Excursion Electrotechnique en Suisse). E. Herbet. An account of a visit made by the pupils of the Ecole Supérieure d'Electricité to the various hydraulic and electric plants in Switzerland, giving interesting data. 4000 w. Le Génie Civil—June 3, 1899. No. 28305 D.

X-Rays.

A Large Static Machine for X-Ray Work. Francis H. Williams. Illustrated description of a machine used for examinations in diseases of the chest, also the method. 1600 w. Sci Am—June 17, 1899. No. 28109.

GAS ENGINEERING

Acetylene.

Acetylene Safer Than Most Other Illuminants. H. F. Fuller. States facts to prove its safety especially from an insurance point of view. 1000 w. Dom Engng—June, 1899. No. 28199 C.

The Acetylene Plant for Lighting the Town of Schönsee (Die Acetylen-Centrale für die Beleuchtung von Schönsee). Paul Wolff. A detailed description of this small municipal plant of 1,000 burners capacity, showing the arrangement of generators, purifiers and distribution. 5000 w. Glaser's Annalen—June 1, 1899. No. 28348 D.

The Use of Acetylene. Edward Ren-

ouf. Gives a review of the progress of this illuminant during the last five years, and predicts that acetylene will soon be a factor in giving an improved and cheaper light. Ill. 5200 w. Ap Pop Sci M—July, 1899. No. 28221 D.

By-Products.

Notes on the Recovery of Residual Products from Coal Gas During the Process of Purification. W Foulis. Read before the Conference of the British Inst. of Civ. Engs. Brief presentation of methods in use, with discussion. 7000 w. Jour Gas Lgt—June 13, 1899. No. 28192 A.

Coke Ovens.

The By-Product Coke Oven for the Manufacture of Illuminating Gas. Henry W. True. Reports the manufacture of illuminating gas in a block of 10 by-product coke ovens at Halifax, N. S. 2000 w. Am Gas Lgt Jour—June 5, 1899. No. 27959.

Explosion.

Chlorate of Potash. Editorial on points connected with the explosion at St. Helens. 1400 w. Engng—May 26, 1899. No. 28001 A.

The Destruction of the St. Helens Gasholder. Illustrated account showing the amount of damage. 900 w. Jour Gas Lgt—May 23, 1899. No. 27937 A.

Fuel Gas.

Dr. Lawson Tait on the Uses of Gas for Fuel. A critical examination of the hints and suggestions presented in a recent lecture advocating gas-heating. 2400 w. Jour Gas Lgt—June 13, 1899. No. 28191 A.

Fittings.

The Extension of Gas Companies' Responsibility to Fittings Beyond the Meter. Frank A. Winstanley. Read before the Incorporated Gas Inst., England. Advocates the extension of the gas manager's control to all appliances necessary for the efficient use of gas. 3000 w. Gas Wld—June 17, 1899. No. 28283 A.

Furnace Gas.

Further Progress in the Application of Blast Furnace Power Gas. (Weitere Fortschritte in der Verwendung von Hochofenkraftgas). F. W. Lürmann. A paper before the *Verein Deutscher Eisenhuttenlente*, giving very full computations as to the mechanical and commercial economy to be expected in the use of furnace gases for motive power. Also discussion. Two articles. 15000 w. Stahl und Eisen—May 15, June 1, 1899. No. 28338 each D.

The Utilization of Furnace Gas for Power. A record of European work in this field is commenced. Part first gives abstract of papers by Enrique Disdier and by Fritz W. Luermann. 2200 w. Ir Age—June 29, 1899. Serial. 1st part. No. 28293.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gas Power.

See Mechanical Engineering, Special Motors.

Hydraulic Main.

The Evolution of the Hydraulic Main. William Carr. Read before the Incorporated Gas Inst., England. Shows how the hydraulic main was made to serve its purpose in the early days of its use, and reviews the improvements made necessary by changed conditions. Discussion. Ill. 11500 w. Gas Wld—June 17, 1899. No. 28277 A.

Labor Saving.

Labor-Saving Appliances in Gas Works. C. C. Carpenter. Read before the Conference of the British Inst. of Civ. Engs. Considers the practice of the South Metropolitan Gas-Works, of London. Discussion. 6500 w. Jour Gas Lgt—June 13, 1899. No. 28193 A.

Liquors.

An Examination of Gas Liquors. Inquiries made to measure the scrubbing and washing efficiency and also to ascertain the distribution of the sulphur. 2500 w. Gas Wld—June 10, 1899. No. 28-179 A.

Naphthalene.

Naphthalene Deposits; Their Cause and Prevention. John P. Leather. Read before the Incorporated Gas Inst., England. Discusses the subject and the remedy most favored by the author. Discussion. 6500 w. Gas Wld—June 17, 1899. No. 28278 A.

The Causes Underlying the Formation of Naphthalene and Their Prevention. Paul Doty. Reviews papers and investigations recently reported from Europe, and gives personal experiences. 5000 w. Am Gas Lgt Jour—June 26, 1899. No. 28238.

Natural Gas.

I. Cincinnati Natural Gas Investigation. II. Natural Gas Supply. The first article gives the principal provisions of the Laidlaw Ordinance and the discussion. The second is the testimony of Edward Orton, the State geologist. 5500 w. Pro Age—June 15, 1899. No. 28143.

Piping.

Gas Piping Topics. Considers incrustation and scale, means of prevention, set

screws, hardening, cutting threads on gas pipes, keeping worn screws in service, double nut, tools, leaks, etc. Ill. 2200 w. Am Gas Lgt Jour—June 12, 1899. No. 28050.

Rare Earths.

On the Luminosity of the Rare Earths When Heated "in vacuo" by means of Cathode Rays. A. A. Campbell Swinton. Describes investigations of the writer of the comparative luminosity of different mixtures of the rare earths. 2000 w. Elec Rev, Lond—June 2, 1899. No. 28084 A.

Rates.

Differential Rates as Between Consumers of Gas for Lighting and for Purposes Other Than Lighting. Thomas Newbigging. Read before the Incorporated Gas Inst., England. Discusses the practice of gas companies in the United Kingdom, which seems to be unfair to customers who use gas only for lighting. Discussion. 11000 w. Gas Wld —June 17, 1899. No. 28275 A.

Regenerative System.

The Advantages of the Regenerative System for Small Gas Works. John Lyne. Read before the Incorporated Gas Inst., England. An account, based upon the author's experience at Wexford, of the benefit resulting from the adoption of this system. Discussion. 5300 w. Gas Wld—June 17, 1899. No. 28282 A.

Retorts.

Recent Experience in Working Inclined Retorts. Charles A. Craven. Read before the Incorporated Gas Inst., England. Gives reasons why this system is favored by the author, describing the experience at the Dewsbury works during 1898. Discussion. 8500 w. Gas Wld—June 17, 1899. No. 28279 A.

Self-Kindling.

Self-Kindling by Chemical Means. Extract from an article in the *Journal für Gasbeleuchtung* on "Self-Kindling of Lighting Gas," by Dr. C. Killing. Considers the modern forms, or those used since the beginning of the century, and especially since the eighties. 800 w. Gas Wld—May 27, 1899. No. 27997 A.

Water Gas.

Carburetted Water Gas, with Reference to the Recent Report of the Departmental Committee. A. G. Glasgow. Read before the Incorporated Gas Inst., England. A discussion of the subject from the gas-makers' side. 8400 w. Gas Wld —June 17, 1899. No. 28276 A.

The Influence of Carbonic Acid on the Combustion of Coal and Carburetted Water Gas. Frederick G. Dexter. Read before the Incorporated Gas Inst., England. Gives valuable information as to the effect of carbonic acid in depreciating the illuminating and calorific values. Usually, the purer the quality of the gas the greater the injury to the illuminating value. Discussion. 3500 w. Gas Wld—June 17, 1899. No. 28281 A.

MARINE AND NAVAL ENGINEERING

MARINE AND NAVAL ENGINEERING.

Armor.

Recent Trials of Cemented Steel Armor Plates (Essais Récents de Plaques en Acier Cémenté). L. Baclé. A discussion of recent trials on hardened armor plates, with tabulated data and results from tests made in England, America, Russia and other countries. Two articles. 4000 w. Le Génie Civil—May 20, 27, 1899. No. 28302 each D.

Argonaut.

Trials and Experiments Made in H. M. S. Argonaut. John Durston. Read before the Inst. of Naval Archts. An account of the results of the contract trials and experiments made while these were being carried out. Ill. 3200 w. Jour Am Soc of Nav Engs—May, 1899. No. 27-991 H.

Beams.

See Mechanical Engineering, Materials.

Cargo Steamers.

Recent Developments in Cargo Steamers. Edward William de Rusett. Read before the Engineering Conference of the Inst. of Civ. Engs., England. General notes on British steamers, considering type, size, construction, capacity, cargo, appliances, ballasting, economy of working. 2200 w. Engng—June 16, 1899. No. 28273 A.

Castle Liners.

The Kinfauns Castle. Describes and illustrates one of the new steamers of the Castle Mail Packets Co., Limited, which will be used in the Cape trade. 2800 w. Engr, Lond—May 19, 1899. No. 27903 A.

Compressed Air.

Compressed Air to Save Ships. Frank Richards. Suggesting the use of air compressors to save the steamship "Paris," and for universal service in like emergencies. 1200 w. Am Mach—June 1, 1899. No. 27935.

Cruiser.

The French Armored Cruiser Jeanne

D'Arc. Details of this vessel, with illustration; also very severe criticism, comparing her with the Br'tish vessels, the "Powerful" and "Diadem." 1500 w. Engr, Lond—June 9, 1899. No. 28187 A.

The Trials of H. M. S. "Hermes." An account of the interesting series of steam trials just completed, which gave important data bearing upon high steam pressures. 1800 w. Engng—June 9, 1899. No. 28181 A.

Express Boilers.

Express Boilers in War Vessels. Information concerning the number of vessels being fitted with boilers of the Yarrow type, espcially by the Dutch Government. 1500 w. Engr, Lond—May 26, 1899. No. 28010 A.

Loading.

The Discharging and Reloading of Large Steamers. William Henry Hunter. Read before the Engineering Conference of the British Inst. of Civ. Engs. Describes briefly the methods of working now in use at the Manchester docks of the Manchester Ship Canal. 2000 w. Engng—June 9, 1899. No. 28182 A.

Merchant Marine.

Merchant Steamers and War Requirements. John Harvard Biles. Read before the Engng. Conference of the British Inst. of Civ. Engs. On the practicability of so constructing merchant steamers as to render them readily available for war purposes. 1000 w. Engng—June 9, 1899. No. 28185 A.

Sea-Power and Sea-Carriage. Benjamin Taylor. An examination of the present extent and conditions of the world's sea-carrying trade, considering the actual shipping of each country, especially the share of Great Britain. 7200 w. Nineteenth Cent—June, 1899. No. 28155 D.

The Need of an American Merchant Marine. Alex. R. Smith. Read at meeting of the Trans-Mississippi Commercial Congress. Introductory to a discussion of the importance of restoring American ships to the foreign carrying trade. 1400 w. Naut Gaz—June 15, 1899. Serial. 1st part. No. 28137.

Passenger Steamers.

Swift Passenger Steamers of Moderate Size. Edwin Lewis Martin. Read before the Engng. Conference of the British Inst. of Civ. Engs. Briefly suggests important considerations which affect the speed, safety and comfort of such vessels. 1200 w. Engng—June 9, 1899. No. 28184 A.

Propulsion.

See Electrical Engineering, Power Applications.

Repair Ship.

The Work of the Naval Repair Ship Vulcan. Gardiner C. Sims and W. S. Aldrich. A noteworthy account of the attempts to raise the sunken Spanish wrecks, and the true story of the loss of the Maria Teresa. 6000 w. Engineering Magazine—July, 1899. No. 28382 B.

Shipbuilding.

Shipbuilding and Shipping Conditions of the United States—Past, Present and Future. George R. M'Dermott. Reviews the conditions of the mercantile marine and the coasting service, discussing also the future of the foreign trade, and the industry of shipbuilding. 2700 w. Marine Engng—June, 1899. No. 28015 C.

COMMUNICATION.

Steam Navigation.

Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America, from 1807 to 1850. (Continued.) Chas. H. Haswell. A continuation of a former paper in order to make the record as complete as possible. 1400 w. Jour Am Soc of Nav Engs—May, 1899. No. 27992 H.

Steamship Performance.

Steamship Performances Compared. J. D. M'Arthur. Abstract of a paper read before the Inst. of Marine Engs., England. Gives the loading dimensions and particulars of the vessels, and the comparative results of their working. 1200 w. Steamship—June, 1899. No. 28081 A.

Steam Yacht.

Full-Powered Sea-Going Steam Yacht Aphrodite for Col. Oliver H. Payne, of New York. William A. Fairburn. Gives details of construction and equipment and report of speed tests. Ill. 3200 w. Marine Engng—June, 1899. No. 28016 C.

Submarine.

Submarine Boats. Lawrence Irwell. A summary of the efforts that have been made during three centuries to build ships for service. 3000 w. Marine Rev—June 1, 1899. No. 27958.

The Progress of Submarine Navigation. Illustrated historical review of all notable plans of submarine boats that have been designed. 1200 w. Sci Am Sup—June 3, 1899. Serial. 1st part. No. 27942.

Torpedo Boat.

Launch of the Stringham. Describes the launch of the largest torpedo boat built or building for the United States Navy; giving also brief accounts of other vessels at the Wilmington, Del., works. 900 w. Marine Rev—June 15, 1899. No. 28152.

Warship Machinery.

Recent Trials of the Machinery of Brit-

ish Warships. Albert John Durston and Henry John Oram. An account of the recent extensive developments in marine engineering practice in the Royal Navy, with record of particulars and results obtained from the machinery of warships. 6500 w. Jour Am Soc of Nav Engs—May, 1899. No. 27989 H.

Water Tubes.

The Water-Tube Boiler in Passenger Steamers. The application of this type of boiler to the Lorna Doone, a pleasure steamer. 1500 w. Engr, Lond—May 26, 1899. No. 28011 A.

Water-Tube Boilers, S. S. Orlando. A report recently issued by the British Board of Trade showing this type of boiler quite unsuited for use with sea water. Also editorial discussing the constructional failures of these boilers. 4000 w. Engr, Lond—June 9, 1899. No. 28186 A.

Yacht Plumbing.

Novel Yacht Plumbing. Illustrates and describes the sanitary arrangements in the new steam yacht "Neaira." 1200 w. Met Work—June 17, 1899. No. 28136.

Yacht.

The Lines and Construction of the Yacht "Columbia." Drawings and description. 1400 w. Sci Am—June 24, 1899. No. 28201.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Electric Vehicles.

Electric Automobiles (Les Automobiles Electriques). M. Schmitt. A general review of the applicability of electric driving for automobile vehicles, and a comparison of costs with animal power. Three articles. 3000 w. L'Electricien—May 6, 27; June 3, 1899. No. 28370 each B.

Waverly Electric Runabout and Columbia Electric Emergency Wagon. Illustrated descriptions of two electric vehicles, exhibited at the recent exhibition in Madison Square Garden, N. Y. 900 w. Sci Am—June 10, 1899. No. 28034.

Bremerhaven.

Electric Tramways and Automobiles in Bremerhaven (Elektrische Strassenbahn in Bremerhaven und Elektrische Automobilen). Dr. Sieg. Discussing mainly the use of storage batteries both for tramway and automobile service. 5000 w. Elektrotech Zeitschr—May 11, 1899. No. 28354 B.

Long Distance.

A Remarkable Automobile Trip. An account of the trip of a Winton motor carriage from Cleveland, O., to New York, a distance of 707.4 miles, being accomplished in 47 hours 29 minutes. 1000 w. Can Engr—June, 1899. No. 28058.

Paris Trials.

Motor Cab Trials in Paris. An account of the trials with description of the vehicles entered. 3500 w. Engr, Lond—June 16, 1899. No. 28260 A.

Road Vehicles.

A Study of Mechanical Traction on Roads (Étude d'une Voiture à Traction Mécanique sur Routes). G. Forestier. A discussion of the conditions of heavy haulage on roads and in city streets, with reference to the design of motor trucks for such service. Serial. Part 1. 5000 w. Le Génie Civil—May 27, 1899. No. 28303 D.

Electric Road Vehicles (Ueber Elektrische Fahrzeuge). Franz Wilking. With numerous illustrations of automobile omnibuses, coaches, cabs, etc. 4000 w. Elektrotech Zeitschr—May 25, 1899. No. 28358 B.

Road Wagons and Motors. Hugh Dolnar. A concise statement of the standing of the motocycle motor. Ill. 2500 w. Am Mach—June 8, 1899. No. 28042.

HYDRAULICS.

Pump.

The Lemaire Pump (La Pompe Lemaire). An illustrated description of an improved form of chain pump of high efficiency, especially adapted for agricultural and colonial use. 1200 w. La Revue Technique—May 25, 1899. No. 28309 D.

Riveted Pipes.

The Joints of Riveted Water Pipes. Emil Kuichling. Abstract of an address before the students of Rensselaer Polytechnic Inst. on the design of riveted steel pipe. 3000 w. Eng Rec—June 10, 1899. No. 28077.

Turbines.

The Blades of the Francis Turbine (Ueber Francis-Turbinenschaufelung). Speidel & Wagenbach. A discussion of the proper curvature of the blades of turbines of the Francis pattern, with geometrical method for laying out. 2500 w. Zeitschr d Ver Deutscher Ing—May 20, 1899 No. 28317 D.

Turbine Installation at Strensham Mills. Describes the successful utilization

of a water-power having a fall of only 2 feet. Ill. 1700 w. Engng—June 2, 1899. No. 28091 A.

Valves.

The Flow of Water Through Valves. Illustrated report of experiments made by Prof. William T. Magruder at the Ohio State University to determine the influence of various types of valves on the discharge of pipes. 2300 w. Eng Rec—June 24, 1899. No. 28234.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Theory and Construction of Ball Bearings. W. H. Hale. Considers the principles of ball bearings and the improvements needed to make them practical and successful. Ill. 2400 w. Sci Am—July 1, 1899. No. 28295.

Castings.

Fillets and Round Corners on Modern Machinery Castings. John M. Richardson. Discusses the value of the fillet in patterns, advantages in the finished casting, and fillets in core work. 2400 w. Ir Trd Rev—June 15, 1899. No. 28138.

Charges.

Shop and General Establishment Charges in Engineering Works and Their Relation to Costs and Estimates. William Edward Cowens. Read before the Brit. Inst. of Engs. and Shipbuilders. Illustrates the method of dealing with these charges. 2200 w. Engs' Gaz—June, 1899. No. 28035 A.

Cone Pulleys.

The Computation of Cone Pulleys (Zur Berechnung des Stufenscheiben-Antriebes). Heinrich Weiss. A development of a graphical method for designing cone pulleys for machine tools for any given series of speeds. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—May 26, 1899. No. 28330 B.

Foundries.

Modern Foundry Buildings. Armin Schotte. Read at the meeting of the Pittsburg Foundry Men's Assn. Considers the best construction to fulfill the conditions required, and recommends the "cementine" as the ideal construction. 2200 w. Ir Trd Rev—June 1, 1899. No. 27936.

Hoisting.

Design of Hoisting Drums for Uniform Torque. John H. Barr. Considers method of determining the curve of a uniform torque drum, discussing other types in use. 1600 w. Sib Jour of Engng—June, 1899 No. 28127 C.

Machine Driving.

See Electrical Engineering, Power.

Molding.

Molding a Corliss Engine Pillow Block. R. H. Palmer. Illustrated detailed description. 1300 w. Am Mach—June 29, 1899. No. 28294.

Molding a Drop Press Bed. R. H. Palmer. Illustrated detailed description. 1200 w. Am Mach—June 8, 1899. No. 28043.

Ornamental Iron.

The Use, Design and Manufacture of Iron in Ornament. Chester B. Albree. Full paper. Discusses ancient and modern work, describing processes of manufacture, and showing the importance of architects and engineers studying how to use this material effectively. Ill. 6000 w. Pro Engs' Soc of W. Penna—March, 1899. No. 28047 D.

Screw Machine.

An Automatic Screw Machine. Illustrates and describes the appearance and construction of a recently perfected machine. 1700 w. Am Mach—June 8, 1899. No. 28041.

Slot Machines.

Coin-Controlled Machinery. Arthur F. Wines. Considers the design of these machines and the defects to be guarded against. Also the application of the mechanism to the automatic telephone. Ill. 1500 w. Sib Jour of Engng—June, 1899. No. 28129 C.

Tools.

Case-Hardening and Annealing. Fred. H. Colvin. Reviews the methods used in small shops. 1500 w. Loc Engng—June, 1899. No. 27906 C.

Works Management.

Machine-Shop Management in Europe and America. H. F. L. Orcutt. A detailed examination of the elements of a modern machine shop, giving the author's conception of the best method of organization and subdivision. 3000 w. Engineering Magazine—July, 1899. No. 28383 B.

MATERIALS OF CONSTRUCTION.

Beams.

Bending Stresses in Z-Beams in Ship-Construction (Die Biegungsspannungen der Z-Eisen zu Schiffbauzwecken). A. Meyerhof. A graphical study of the bending stresses, with very complete tables of the moments of resistance for various sections. 6000 w. Zeitschr d Ver scher Ing—May 27, 1899. No. 28319 D.

Bronzes.

A Study of the Micro-Structure of Bronzes. E. Heyn. A contribution to the subject of metallography, with a criticism of A. E. Outerbridge's paper.

Ill. 5000 w. Jour Fr Inst—June, 1899. No. 27980 D.

Copper Alloys.

The Endurance of the Ordinary Copper Alloys in Sea Water. Herr Diegel. Abstract translation of an article in *Marine-Rundschau*. An account of experiments made on sheathing for vessels, describing tests and giving results. 8500 w. Jour Am Soc of Nav Engs—May, 1899. No. 27990 H.

Crucible Steel.

The Crucible Steel Works of J. Braun's Sons at Schloss Schöndorf (Die Tiegel-Gusstahlfabrik von J. Braun's Söhnen in Schloss Schöndorf). With plans of the furnaces and illustrations of armor-plate products. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Huttenwesen —May 27, 1899. No. 28345 B.

Low Temperatures.

The Effect of Low Temperatures upon Certain Steels (De l'Effet des Basses Températures sur Certains Aciers). F. Osmond. Discussing experiments made upon steel cooled with liquid air, especially with regard to its magnetic properties. 1000 w. Comptes Rendus—June 5, 1899. No. 28316 D.

Steel Castings.

Experiments on the Elasticity, Tensile Strength and Elongation of Steel Castings (Versuche über Elastizität, Zugfestigkeit Dehnung und Arbeitsvermögen von Stahlguss). C. Bach. With tabulated results of tests at various temperatures. 1500 w. Zeitschr d Ver Deutscher Ing—June 10, 1899. No. 28324 D.

POWER AND TRANSMISSION.

Belts.

Power Consumed by Shafting and Belts. C. H. Benjamin. An account of experiments made by senior students of Case School of Applied Sciences under the direction of the writer. 1200 w. Ir Trd Rev—June 8, 1899. No. 28039.

Conveyors.

Coal Conveyors. Extract from paper by Charles Piez, Philadelphia. Considers bucket conveyors, link-belt conveyors and the scraper conveyor. 2000 w. Gas Wld —June 3, 1899. No. 28082 A.

Handling Minerals.

Economy in Handling and Transport of Minerals. Charles de Neuville Forman. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Calls attention to the importance of this subject, offering suggestions. 1200 w. Col Guard—June 16, 1899. No. 28263 A.

How Ore Is Handled. Illustrates and describes the ore-handling machinery and methods used at Conneaut, Ohio, on Lake Erie. 2800 w. Marine Rev—June 22, 1898. No. 28237.

SPECIAL MOTORS.

Air Motors.

Compressed Air Motors in New York. An illustrated detailed description of the air-power system as in use in New York, which differs in many respects from that used in Europe. 3500 w. St Ry Jour—June, 1899. No. 27952 D.

Gas Engines.

Gas Engines: The Number in Use and Their Applications. Bryan Donkin. A summary of information obtained by sending circulars to the gas companies of the United Kingdom. 1000 w. Jour Gas Lgt—May 30, 1899. No. 28045 A.

The Evolution and Future of the Gas Engine. Georg Lieckfeld. A review of the historical development of the internal combustion motor, showing the lines along which its future successful development may be expected. 3500 w. Engineering Magazine—July, 1899. No. 28388 B.

Gas Power.

Gas for Motor Purposes. T. Ormiston Paterson. Read before the Incorporated Gas Inst., England. The author believes that gas has a great future awaiting it in this field. Gives data obtained by experiments with different gases and information bearing upon this subject. Discussion. 10000 w. Gas Wld—June 17, 1899. No. 28280 A.

Oil Engines.

The Commercial Advantage of the Oil Engine. John A. Secor. Considers the use of kerosene as a fuel in internal combustion motors, its thermodynamic value, price, features of the oil motor, etc. 1800 w. Mach, N. Y.—June, 1899. No. 27928.

Petroleum.

Petroleum Motors (Ueber Motorenbetrieb mit Erdölen). Ludwig Loos. A review of the development of petroleum motors, and a comparison of the fuel consumption of various types. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—June 16, 1899 No. 28333 B.

STEAM ENGINEERING.

Boiler Accident.

A Peculiar Boiler Accident—Result of a Vacuum. From the British *Shipping Gazette*. An accident on the British steamer "Elderslie" is described, which caused the death of the third engineer in a most unusual manner. 900 w. Am Mach—June 15, 1899. No. 28101.

Boiler Installation.

The Installation of Steam Boilers.

Critical discussion of details of boilers and their surroundings, with a view to showing the causes of present practice. 1500 w. Elec Rev, Lond—June 16, 1899. Serial. 1st part. No. 28248 A.

Boilers.

The Computation of Steam Boilers (Berechnung der Dampfkessel). E. Brauss. A discussion of the proper dimensions of a boiler for a steam-heating system, taking into account various fuels. Data concerning chimneys are also given. 2000 w. Gesundheits-Ingenieur—May 15, 1899. No. 28335 B.

Boiler Test.

Test of a Babcock & Wilcox Boiler Built for the Alert. Gives the general dimensions of the boilers, pointing out wherein they differ from others heretofore built for vessels of the U. S. Navy, and describes the tests made. 4800 w. Jour Am Soc of Nav Engs—May, 1899. No. 27988 H.

Condensing.

Central Steam Condensing Plants. From *Stahl und Eisen.* Calls attention to the advantages, and reasons for rapid development of this new branch of steam engineering; and gives an illustrated detailed description of such a plant. 3800 w. Ir & Coal Trds Rev—June 16, 1899. No. 28284 A.

The Central Condensing Plant of the Recklinghausen Mine (Die Central Kondensation des Schachtes Recklinghausen). With detailed description of this large surface condensing plant and a record of its performance over a period of six months. 2500 w. Glückauf—June 3, 1899. No. 28342 B.

Connecting Rods.

On the Connecting-Rod Problem. Prof. Dunkerley. Gives the solution to four stated problems, considering simply the effect of the inertia of the rod. 4700 w. Engng—June 2, 1899. No. 28090 A.

Efficiency.

The Efficiencies of Steam Boilers and Furnaces. R. S. Hale. An examination of the conditions upon which boiler and furnace efficiency depend, based upon a comparative study of a large number of tests. 3500 w. Engineering Magazine—July, 1899. No. 28385 B.

Engines.

German Rolling Mill Engines. C. Kiesselbach. Abstract of a paper read before the Verein Deutscher Eisen Huettenleute. An illustrated review of recent development in this class of engines, discussing the general points of compound engines in this first part. 3500 w. Ir Age—June 8, 1899. Serial. 1st part. No. 28029.

Rolling Mill Engines (Die Motoren zum Antrieb der Walzenstrassen). C. Kiesselbach. A paper read before the *Verein Deutscher Eisenhuttenleute,* giving a very detailed account of German practice, with many illustrations. The discussion is appended. Two articles, 10 plates, 15000 w. Stahl und Eisen—May 1, 15, 1899. No. 28336 each D.

Explosion.

Boiler Explosion in a Brewery. Illustrates and describes a recent boiler explosion at the plant of the Standard Brewing Co., Rochester, N. Y. 1000 w. Locomotive—June, 1899. No. 28274.

Express Boilers.

See Marine and Naval Engineering.

Furnaces.

Furnace Fittings. Part first discusses furnace casing, and cold-air supply and connections. 2000 w. Met Work—June 3, 1899. Serial. 1st part. No. 27945.

The Heckmann Furnace (Die Heckmann Feuerung). H. Blezinger. Describing and illustrating an improved form of regenerative furnace, adapted both for steam boilers and for metallurgical purposes. 2500 w. Zeitschr d Ver Deutscher Ing—June 17, 1899. No. 28327 D.

Governor.

The American Inertia Governor (Die Amerikanischen "Inertie" Regulatoren). A. Stodola. A general discussion of shaft governors of the inertia type, with illustrations from recent American practice. 2000 w. Schweizerische Bauzeitung—May 20, 1899. No. 28350 D.

High Speed.

Quick Revolution Steam Engines. Arthur Herschmann. Historic review of the evolution of quick-revolving engines, considering the present practice and discussing the merits of a few types. Ill. 6000 w. Pro Engs' Soc of W. Penna—April, 1899. No. 28048 D.

Mechanical Draft.

The Influence of Mechanical Draft Upon the Ultimate Efficiency of Steam Boilers. Walter B. Snow. Describes the apparatus employed in the production of mechanical draft, shows the economy in first cost in part first. Ill. 1900 w. Heat & Ven—June, 1899. Serial. 1st part. No. 28290.

Pressure.

Something About Pressure. W. H. Wakeman. Gives a list of various pressures, showing how some of them are misplaced, and gives directions for calculating different pressures. 2800 w. Engr, U. S. A.—June 1, 1899. No. 27985.

Regulator.

The Sandillon Pressure Regulator (Detendeur Regulateur de Pression, Système Sandillon). J. Loubat. With reports of trials both of the pressure regulator and of an automatic boiler feeder of similar design. 2000 w. La Revue Technique—June 10, 1899. No. 28311 D

Superheating.

Improvements in the Use of Steam (Veredelung des Wasserdampfes). A. Hering. A discussion of the economy effected by superheating, with illustrations of superheaters and data of tests 5000 w. Zeitschr d Ver Deutscher Ing—June 10, 1899. No. 28325 D.

Thermodynamic Action of "Steam-Gas." R. H. Thurston. On the valuable paper by Prof. Sinigaglia, published in the *Revue de Mecanique*. 1100 w. Sib Jour of Engng—June, 1899. No. 28128 C.

The Application of Superheated Steam to the Driving of Steam Engines (Die Amvendung Ueberhitzten Dampfes zum Betriebe von Dampfmaschinen). R. Doerfel. The beginning of an exhaustive study of the use of superheated steam; collecting and discussing tests. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—May 27, 1899. No. 28318 D.

Traction Engines.

Electric Light and Traction Engines. The object of the article is to describe some specimens of the work of English engine-makers. Ill. 1700 w. Elec Rev, Lond—June 16, 1899. No. 28249 A.

Water Tubes.

See Marine and Naval Engineering.

Working Loads.

Investigation of the Actual Working Loads, Stresses, etc., on the Moving Parts of a Compound Non-Condensing Steam Engine. Q. E. D. Investigations of interest in showing the methods of determining the various stresses, etc. Describes the engine used. 1800 w. Prac Engr—May 26, 1899. Serial. 1st part. No. 27996 A.

MISCELLANY.

Air.

Mixtures of Air and Watery Vapor. Frank Richards. Diagrams are given and explained, of interest in studying the problem of controlling the relative humidity of air by means of its artificial compression and expansion. 900 w. Am. Mach—June 22, 1899. No. 28196.

Air Compressor.

Mammoth Air Compressor for Street Railroad Motors. Illustrated description of the plant for supplying the air motors in the cars of the Metropolitan Street Railway Co., New York. 1200 w. Ir Age—June 8, 1899. No. 28028.

Two Pipe Air Compression. Charles Cummings. A reply by the inventor to Mr. Chodzko's criticisms of the Cummings system. 2200 w. Mod Mach—June, 1899. No. 27984.

Artillery.

The Law of Pressure at the Muzzle of a Gun (Sur la Loi des Pressions dans les Bouches à Feu). M. Vallier. A communication to the French Academy discussing the distribution of pressures at various points in the barrel of a gun. 1200 w. Comptes Rendus—May 29, 1899. No. 28315 D.

Chronometer.

The Laws of the Variations in Amplitude of Chronometer Balances (Lois des Variations d'Amplitude du Balancier des Chronomètres). Marcel Brillouin. Describing the method of photographing continuously the vibrations of a balance wheel, enabling the variations to be recorded and studied. 10000 w. Bull de la Soc d'Encorur—May, 1899. No. 28314 G.

Compressed Air.

Compressed Air to Ring the Bells of St. Patrick's. Brief description of the mechanism being installed to ring this chime of nineteen bells. 700 w. Am. Mach—June 8, 1899. No. 28040.

See Marine and Naval Engineering.

Explosion.

The Toulon Explosion. J. T. Bucknill. An account of the great explosion on March 5 of two magazines, the cause still remaining a mystery. 2200 w. Engng—May 26, 1899. No. 27999 A.

Institution Home.

The Institution of Mechanical Engineers. A brief historical sketch of the British Society, with an illustrated description of the new building in London. 2800 w. Engng—May 19, 1899. No. 27900 A.

Liquid Air.

A Plant for the Commercial Manufacture of Liquid Air. Illustrates and describes a plant soon to be put in operation in New York, with an estimated capacity of about 1,500 gallons per day. 3000 w. Eng News—June 8, 1899. No. 28027.

Liquid Air and Explosives Frederick H. McGahie. A discussion of the efforts being made to utilize liquid air in explosives, and the limited success thus far obtained. 2400 w. Sci Am Sup—June 3, 1899. No. 27944.

Liquid Air. W. Hampson, in *British Refrigeration*. Historical review of facts connected with this subject, with criticism of statements attributed to Mr.

Charles E. Tripler. 3500 w. Sci Am Sup—July 1, 1899. No. 28297.

Refrigeration.

Operating Ice Machines. W. H. Wake-Man. Practical suggestions to engineers in charge of ice or refrigerating machinery. Explains how a machine is rated and how to calculate capacity. 2700 w. Ice & Refrig--June, 1899. No. 27983 C.

Smoke.

On Smoke and Its Diminution. Bryan Donkin. Part first considers the need of pressure to secure the prevention of smoke, its nature, combustion, determination, smoke scales, etc. 3000 w. Engr, Lond—May 26, 1899. Serial. 1st part. No. 28007 A.

Terra Cotta.

The Manufacture of Terra Cotta. Walter P. Rix. The object of the article is to point out some of the causes of failure and to suggest the best method of overcoming the obstacles. 3300 w. Brick—June 1, 1899. No. 28031.

MINING AND METALLURGY

COAL AND COKE.

Anthracite Mines.

Mining and Ventilating Anthracite Mines with Increasing Depths. H. O. Prytherich. Suggestions as to improved methods. 3000 w. Mines & Min—June, 1899. No. 27967 C.

Bituminous Coals.

Comparative Tests of Bituminous Steam Coals. John W. Hill. An account of valuable experimental work by the author on the various bituminous steam coals, to determine the most economical coal for steam purposes. Comparative results are given 14000 w. Pro Am Soc of Civ Engs—April, 1899. No. 28116 E.

Briquettes.

Apparatus for Testing Pitch for Briquette Making. O. Binder, in *Oesterreichische Zeitschrift fur Berg und Huttenwesen.* Describes apparatus and method of working by means of which the suitability of pitch for briquettes may be ascertained. 1100 w. Col Guard—June 16, 1899. No. 28267 A.

Cape Breton.

The Sydney Coalfield, Cape Breton. Harrison F. Bulman. An account of the collieries of the Dominion Coal Company and of the General Mining Association. 3800 w. Col Guard—June 2, 1899. No. 28092 A.

Coal Cutting.

Coal-Cutting Machinery from the Humanitarian Point of View. Ernest Kilburn Scott. A study of the subject, showing the superiority of machinery over hand labor, and the saving of life resulting from its adoption. 1000 w. Elec Rev, Lond—June 9, 1899. No. 28178 A.

Coal Transportation.

The Transport of Coal on the Ohio and the Lower Mississippi. James H. Bartlett. A description of transportation, overcoming difficulties due to the intermittent character of the navigation, and the magnitude of the undertaking. 6500 w. Col Guard—June 2, 1899. No. 28095 A

Coke Ovens.

By-Product Coke Ovens. Evence Coppée. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Gives results obtained in the Coppée recovery system. Discussion. 2500 w. Col Guard—June 16, 1899. No. 28264 A.

Fuel Analysis.

Examination and Analysis of Mineral Fuel by Roentgen Rays. Henry Couriot. From a communication to the Société de l'Industrie Minérale. Describes the method and apparatus used, and examination of specimens. 3700 w. Col Guard—May 26, 1899. No. 28006 A.

Kent, Eng.

The Kentish Coalfields. Explains the views of geologists which have led to a search for coal deposits, and describes the Dover workings. 3500 w. Engr, Lond—May 26, 1899. No. 28008 A.

Mining Improvements.

Modern Improvements in Coal Mining: Winding from Deep Mines. Henry William Martin. Read at the Engineering conference of the Inst. of Civ. Engs., England. Describes the main features of the winding machinery at a new colliery in South Wales. 2000 w. Engr, Lond—June 16, 1899. No. 28255 A.

Pittsburg.

Pittsburg, with Its Black Diamonds. A. P. Kirtland. An account of this city and its industries, all of which is attributed to the coal in that locality. Ill. 5800 w. Pro of Engs Soc of W Penna—May, 1899. No. 28286 D.

Silesia.

The Principal Coal Deposits of Upper Silesia (Die Hauptstörung des Oberschlesischen Steinkohlenbeckens). C Gaebler. With an extensive map and

geological section and a review of the development of the region. 5000 w. Glückauf—May 27, 1899. No. 28341 B.

COPPER.

Copper.

Copper. Arthur Lakes. Describes its ores, their appearances and values, how they occur, and the peculiarities to be noticed. 1800 w. Mines & Min—June, 1899. No 27964 C.

GOLD AND SILVER.

Alaska.

Gold Mining in Alaska: Notes from the Klondike. On the promising conditions of these fields, and interesting information relating to their development. 2300 w. U. S. Cons Repts, No. 447—June 9, 1899. No. 28049 D.

Bathurst.

The Gold Diggings at Bathurst in 1851. Henrietta Huxley. An interesting account of the excitement in New South Wales at the time of the discovery of gold, describing also the diggings. 4200 w. Nineteenth Cent—June, 1899. No. 28154 D.

British Columbia.

British Columbia Mines in 1898. W. M. Brewer. Information from the annual report of the Minister of Mines. 900 w. Eng & Min Jour—June 10, 1899. No. 28067.

Cyaniding.

Cyaniding Slimy Ores and Tailings. Matt. W. Alderson. Part first is a brief historical account of the early attempts to treat slimes in Montana. 1300 w. Min & Sci Pr—June 3, 1899. Serial. 1st part. No. 28046.

Klondike.

Geology of the Klondike Gold Fields. Angelo Heilprin. An interesting illustrated description of this region. 6400 w. Ap Pop Sci M—July, 1899. No. 28220 D.

Mexico.

The Topia District, Durango, Mexico. Frank B. Fowler. Describes this region; the ores are of silver, carrying a high percentage of lead. 1700 w. Eng & Min Jour—June 3, 1899. No. 27957.

Mining Practice.

Modern Practice in Gold Mining. John Hays Hammond. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Classifies and briefly discusses the problems. 1200 w. Col Guard—June 16, 1899. No. 28268 A.

New Zealand.

Report on the Auriferous Deposits of the Upper Hinemaia River. Alexander McKay. The government geologists' report of the Taupo district, Auckland, N. Z. Did not find a payable prospect. 1600 w. N Z Mines Rec—April 17, 1899. No. 28033 B.

Nova Scotia.

The Pictou Coalfield, Nova Scotia. Harrison F. Bulman. An account of the colleries, the methods of working, equipment, management, etc. 3000 w. Col Guard—June 16, 1899. No. 28262 A.

Philippines.

Native Metallurgy in the Philippines. R. L. Packard. Describes the working of gold-bearing rock, and copper smelting. 1500 w. Eng & Min Jour—June 17, 1899. No. 28151.

Production.

The Increasing Production of Gold. Dr. H. M. Chance. A discussion of the enormous increase in the world's production of gold, and its effect upon prices of general commodities. The writer's prediction of three years ago is shown to be amply fulfilled. 3000 w. Engineering Magazine—July, 1899. No. 28381 B.

United States Gold and Silver Production in 1898. The corrected estimate, showing a very large gold production and an increase in silver. 1500 w. Eng & Min Jour—June 10, 1899. No. 28065.

Sampling.

Methods of Testing and Sampling Placer Deposits. Edmund B. Kirby. Read before the Colorado Scientific Society. Describes the best way of carrying on the work. 2000 w. Min & Sci Pr—June 17, 1899. Serial 1st part. No. 28207.

Notes on Mine Sampling. George J. Bancroft. Describes the methods in use, and the most satisfactory. Also the method of estimating the value of the mine. Ill. 2000 w. Min & Sci Pr—June 17, 1899. No. 28206.

Slimes.

Filter-Press Process of Gold Ore Slimes. William McNeill. Abstract of paper read before the Inst. of Min. and Met. in London. The process consists in the coagulation of the slimy particles by adding lime, settlement and treatment by weak cyanide solutions. 2800 w. Min & Sci Pr—June 17, 1899. No. 28208.

The Indirect Advantages of a Slimes Plant. John R. Williams. Notes claiming an increase in amalgamation and other profits. Discussion. 2000 w. Jour of Chem & Met Soc of S Africa—April, 1899. No. 27993 E.

South Africa.

Pilgrim's Rest. Malcolm Fergusson. Describes the situation of this rich South African field, its geological formation,

and the conditions under which it is worked. Ill. 1600 w. Mines & Min—June, 1899. Serial. 1st part. No. 27961 C.

Sulphides.

Reduction of Sulphides. The new process for the treatment of the sulphides of Broken Hill and Mount Reid in Australia. 3000 w. Aust Min Stand—May 11, 1899. No. 28252 B.

Tasmania.

Mining in Tasmania. A review of the great progress in this industry, and in the industries dependent on it. 11000 w. Aust Min Stand—April 27, 1899. No. 28036 B.

The Mount Read Mines. Report of the deposits and the difficulties arising from the presence of zinc. Ill. 5500 w. Aust Min Stand—April 27, 1899. No. 28037 B

Testing.

Testing Gold Ores for Treatment by Concentration and Amalgamation to Determine the Best Method of Extraction. H. Van F. Furman. Describes laboratory work by which the kind of mill or the process suited to any ore can be determined before going to the expense of a mill test. Ill. 3200 w. Mines & Min—June, 1899. No. 27960 C.

Transvaal.

Mechanical Problems with Special Reference to Gold Mining in the Transvaal. Fearnside Irvine. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Gives the practice in mine pumping, deep-level hoisting, ventilation, milling, treatment, etc. 1500 w. Col Guard—June 16, 1899. No. 28269 A.

The Rose Deep Gold Mine. Brief account of the methods now in use for the extraction of the metal from the ore, illustrated by photographs of the machinery employed at the mine named, situated near Johannesburg, in the Transvaal. 1500 w. Engr, Lond—June 16, 1899. No. 28261 A.

IRON AND STEEL.

Bar Iron.

Suggested Improvements in the Manufacture of Bar Iron. Samuel Peters. Describes a method which the author thinks will give desirable results, and it is hoped furnish a wrought iron that will compete with steel. 2500 w. Pro of Engs Soc of W Penna—May, 1899. No. 28287 D.

Books.

Best Books for an Iron and Steel Works Chemist. Albert Ladd Colby. Calling the attention of chemists to the best English and American books in the various branches of his analytical work, and warning him against the poor ones. 3000 w. Ir Age—June 15, 1899. Serial. 1st part. No. 28102.

Cast Iron.

Crystallization and Segregation of Cast Iron C. Kreuzpointner Extract from a discussion of a paper on "The Deceptive Fracture of Pig Iron," by Thomas D. West, read before the Am. Foundrymen's Assn. Showing that it is not the chemical composition alone that secures a sound casting. 1500 w. Eng News—June 1, 1899. No. 27933.

Crucible Steel.

See Mechanical Engineering, Materials.

Furnace Gas.

See Gas Engineering.

Iron Ore.

Our Iron Ore Supplies. Walter J. May. Suggestions for increasing the supplies of native iron ores without increasing the prices. 1000 w. Col Guard—May 26, 1899. No. 28005 A.

The Iron Ores of the Oural Mountains, Russia. H. B. C. Nitze. An illustrated description of this region, the development of the mines, the ores, etc. 1200 w. Jour Fr Inst—June, 1899. No 27979 D.

Iron Production.

An Economic Study of the World's Production of Iron Ore and Pig Iron (Volkswirthschaftliche Studien über die Gewinnung der Eisenerze und die Erzengung von Roheisen auf der Erde). Franz Kupelwieser. A very complete statistical review, with results tabulated by countries. Three papers, 12000 w. Zeitschr d Oesterr Ing u Arch Ver—June 2, 9, 16, 1899. No. 28331 each B.

Iron Trade.

A Review of the Iron Trade: Its Condition and Prospects. Charles Lancaster. Address before the Liverpool Chamber of Commerce. Considers the conditions in Great Britain. 1200 w. Col Guard—May 26, 1899. No. 28004 A.

Lapland.

The Great Magnetite Deposits of Swedish Lapland. David A. Louis. An account of the rich iron ore deposits of Northern Europe and the opening up of the region by railway construction. 3000 w. Engineering Magazine—July, 1899. No. 28386 B.

Puget Sound.

A Pacific Situs for Iron-Making. W. C. Cronemeyer. Investigations of the region around Puget Sound, to ascertain the prospects which that part of the country offered for the manufacture of

iron and steel. 3000 w. Ir Trd Rev—June 15, 1899. No. 28139.

Silicon.

Carbide of Silicon: Its Purpose and Use in Steel. F. J. Tone. Explains the action of silicon on foaming or boiling steel, its advantage over ferro-silicon, and the range of its application. 1800 w. Ir Age—June 22, 1899. No. 28195.

Slag.

The Utilization of Blast Furnace Slag. Alex. D. Elbers. Part first discusses the possibilities of this product, considering the most promising to be the utilizing it for building material. 1600 w. Eng & Min Jour—June 3, 1899. Serial. 1st part. No. 27955.

Steel Castings.

See Mechanical Engineering, Materials.

Temperature

The Influence of Casting Temperature Upon Steel. Robert Abbott Hadfield. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Suggesting lines upon which research work should be based and indicating the present knowledge of this subject. 900 w. Col Guard—June 16, 1899. No. 28265 A.

MINING.

Air Pumps.

Points in Repairing Mining Air Pumps. Suggestions, with illustrations, for light repairs and cleaning. 1300 w. Am Mfr & Ir Wld—June 16, 1899. No. 28148.

Air Shafts.

Deepening an Air Shaft Under Difficulties. Illustrates and describes the most interesting portion of the work for rectifying the air-shaft of the Perron pit at the Bois d'Avroy Colliery, in the Province of Liége. 500 w. Col Guard—June 2, 1899. No. 28093 A.

Austria.

Austrian Mining Industries in 1897 (Der Oesterreichische Berguerksbetried im Jahre 1897). Tabulated statistics from the official reports, classified and compared with the preceding year. 2500 w. Glückauf—June 10, 1899. No. 28344 B.

Cornish Mining.

The Position and Prospects of Cornish Mining. Joseph S. Martin. Notes from the annual report for 1898. Urging that the mines be properly equipped and wisely managed. 2000 w. Col Guard—May 26, 1899. No. 28003 A.

Dynamite.

Notes on Handling Dynamite. W. R. Quinan. Written for the report of the mines inspector for Montana, for 1897. Describes how it should be stored, and how thawed and exploded. Also its effect on ventilation. 1500 w. Mines & Min—June, 1899. No. 27966 C.

Electric Power.

Electrical Transmission of Power in Mining. William Beedie Esson. Read before the British Inst. of Civ. Engs. Describes the plant at the Sheba Company's mines, Barberton, Transvaal. Ill. 8000 w. Col Guard—June 9, 1899. No. 28189 A.

Equalizing.

The Hoist Equalizer of the Camphausen Mine near Saarbruck (Der Seilgewichts-Ausgleichung der Grube Camphausen bei Saarbrücken). Describing the ingenious method of counterbalancing the variable weight of the cable in the hoisting machinery. 2000 w. Glückauf—June 3, 1899. No. 28343 B.

Explosives.

Experience with the Explosives Order in the Midlands. A. H. Stokes. From the inspector's annual report. Cautioning against placing too much reliance in the Woolwich test of explosives, with information relating to the use and care of explosives. 2800 w. Ir & Coal Trds Rev—May 26, 1899. No. 28014 A.

Recent Investigations as to Safety Explosives. M. G. Chesneau. From a communication to the French Firedamp Commission. Gives briefly the results that have been obtained in France, and reviews the results obtained in other countries. 4500 w. Col Guard—June 9, 1899. No. 28188 A.

The Safe Handling of High Explosives. Comments on the changes being made in the explosives used in mines, and the miners' unfamiliarity with the properties of those now used, giving the principal points to be observed in order to handle them with safety. 5000 w. Col Guard—June 9, 1899. Serial. 1st part. No. 28190 A.

Firedamp.

Continuous Examination of Pit Gas for Firedamp by the Krell Apparatus. P. Fuchs, in *Zeitschrift für Berg-Hutten und Salinenwesen.* Illustrated description of this method, which is based on the principle of the hydrostatic balance, and of the apparatus used. 1600 w. Col Guard—May 19, 1899. No. 27904 A.

Errors in Firedamp Control (Die Häufigsten Fehler bei der Wetterführung). A paper by Bergassessor Stens, discussing the proper method of mine ventilation to prevent the accumulation of fire damp. 2500 w. Glückauf—May 13, 1899. No. 28339 B.

Hoisting.

See Mechanical Engineering, Machine Works.

Ignition.

Progress in the Electric Ignition of Explosives (Fortschritte auf dem Gebiete der Elektrischen Zündung von Sprengschüssen). Bergassessor Heise. With a description of the electric igniters now in practical use and a discussion of the electrical features of the work. 3000 w. Glückauf—May 20, 1899. No. 28340 B.

Mining Law.

Royalties and Wayleaves and Their Treatment. George Johnson. An explanation of these terms and difficulties arising from them in the United Kingdom. 2800 w. Col Guard—June 2, 1899. No. 28094 A.

Mining Power.

See Electrical Engineering, Power Applications.

Old Mines.

Dangers of Old Mine Workings. Arthur Lakes. Gives some examples of how these dangers have been successfully met, and of accidents which they have caused. Ill. 1600 w. Mines & Min—June, 1899. No. 27965 C.

Ontario.

Mining in Ontario: Its Condition and Outlook. A review of the various branches of this industry. The production of petroleum, salt, natural gas, gold, iron, nickel, copper and other minerals. 2500 w. Can Min Rev—May 31, 1899. No. 27986 B.

Rescue Work.

Life Saving in Mines, with Special Reference to the Coal Mining District at Ostrau-Karwin, Austria. A paper read by Mining Engineer H. Rossner, manager of the Archducal Shaft of Hohenegger, before a meeting of German engineers in Munich. Ill. 3600 w. Mines & Min—June, 1899. No. 27962 C.

Shafts.

Iron Lining to Shaft for Catching the Water. M. Vrancken. From an administrative report published in the *Annales des Mines de Belgique*. Describes the manner of overcoming the incursion of water in the winding shaft. 1400 w. Col Guard—June 16, 1899. No. 28266 A.

Timbering.

Mine-Timbering and Accidents in Mines. A. H. Stokes. Suggestions of a general character, considering the timbering of roadways, removal of broken pumps, setting bars, setting props in the stalls, etc. 2800 w. N Z Mines Rec—April 17, 1899. No. 28032 B.

Timbering Underground Workings. George L. Kerr. Extract from a paper read before the Min. Inst. of Scotland. Illustrates and describes the kind of timber and the methods of setting for supporting workings in various kinds of ground. 1400 w. Mines & Min—June, 1899. No. 27963 C.

Underground Water.

Underground Water. An interesting case recently decided in the Court of Appeal, England. 2500 w. Col Guard—May 26, 1899. No. 28002 A.

Water. W. M. Watson. On the supply of water, how to tell where water will be found by boring, the importance of a pure supply, and some facts concerning mineral springs, etc. 3000 w. Can Engr—June, 1899. No. 28057.

MISCELLANY.

Bismuth.

Bismuth Ores in N. S. W. J. A. Watt. Gives some of the characteristics and uses of this comparatively rare metal, with a list of the localities in New South Wales from which bismuth ores have been recorded. 3800 w. Aust Min Stand—May 4, 1899. Serial. 1st part. No. 28038 B.

Bronzes.

See Mechanical Engineering, Materials.

Conveyor.

See Mechanical Engineering, Power and Transmission.

Graphite.

Graphite: Its Formation and Manufacture. E. G. Acheson. Gives the early history, distribution, uses, manufacture, theory of formation, etc. 4500 w. Jour Fr Inst—June, 1899. No. 27981 D.

Handling Minerals.

See Mechanical Engineering, Power and Transmission.

Onyx.

The Onyx Deposits of Barren County, Kentucky. S. S. Gorby. An illustrated description of the deposits and their location. 1500 w. Eng & Min Jour—June 17, 1899. No. 28150.

Phosphate.

The Mount Pleasant Phosphate District, Tennessee. H. D. Ruhm. An account of this field, where somewhere near $600,000 have been invested. 2200 w. Eng & Min Jour—June 10, 1899. No. 28068.

Pyrometer.

The Uehling and Steinbart Pneumatic Pyrometer (Pneumatisches Pyrometer von Uehling & Steinbart). With detailed drawings and a photographic view

of the apparatus. 2000 w. Stahl und Eisen—May 1, 1899. No. 28337 D.

Salt Deposits.

The Strassfurt Region Salt Deposits in Germany. H. B. Nitze. Describes these deposits with special reference to the potassium and magnesium salts. 2600 w. Mines & Min—June, 1899. No. 27968 C.

Slag.

Potash and Soda Salts from Natural Decomposition of Lead Slags. Malvern W. Iles and Charles F. Shelby. A statement of facts obtained in the analysis of a white efflorescent salt found at the base of a slag dump. 600 w. Eng & Min Jour—June, 1899. No. 27956.

Structure.

The Crystalline Structure of Metals. J. A. Ewing and W. Rosenhain. Abstract of the Bakerian lecture before the Royal Soc. Some results of microscopical study considering the effects of strain and the relation of plasticity to crystalline structure. 2200 w. Elect'n, Lond—June 9, 1899. No. 28176 A.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

English Railroad Accidents in 1898. Editorial comment on the Board of Trade report. 1000 w. R R Gaz—June 2, 1899. No. 27941.

Train Accidents in the United States in April. Detailed list and classified summary. 2500 w. R R Gaz—June 2, 1899. No. 27940.

Paris Exposition.

Railways at the Paris Exposition. Willard A. Smith. The first of a series of articles aiming to give an idea of the plans and prospects of the American exhibit of transportation and civil engineering. 1500 w. Ry Mas Mech—June, 1899. Serial. 1st part. No. 28147.

Special Train.

A Run with a Webb Four-Cylinder Compound. Charles Rous-Marten. An account of a special trip of the Engineering Conference of the Inst. of Civ. Engs. from London to Crewe and back. 1800 w. Engr, Lond—June 16, 1899. No. 28259 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Appliances. Report of the committee of the M. C. B. Assn., presented to the annual convention at Old Point Comfort. Ill. 1000 w. Ry Age—June 16, 1899. No. 28144.

Organizing and Conducting the Air Brake Department of a Railroad. Extracts from a paper presented at meeting of the Assn. of R. R. Air-Brake Men, in Detroit. Suggestions of what should be required. 1000 w. Ry & Engng Rev—June 3, 1899. No. 28020.

Brake Beams.

Solid Brake Beams. R. H. Angier. A discussion of metal brake beams, describing the practice of European railroads. Also editorial. Ill. 3200 w. R R Gaz—June 9, 1899. No. 28054.

Cars.

100,000-Pound, Steel Frame, Hopper Cars—Norfolk & Western Railway. Illustrated description. Also arguments by R. P. C. Sanderson favoring this form of construction. 2500 w. Am Engr & R R Jour—June, 1899. No. 27920 C.

Car Wheels.

The Heating of Car Wheels and Its Relation to the Heat Test. Gives results of some novel experiments for determining the temperature to which drilled wheels can be heated by brake shoes under severe conditions, and the relation of this heating effect to the usual thermal test. Also editorial. 4200 w. R R Gaz—June 9, 1899. No. 28053.

Couplers.

A Possible Solution of the Coupler Problem. Discusses the report of the M. C. B. Coupler Committee, outlining a plan for solving the coupler problem. 1300 w. R R Gaz—June 9, 1899. No. 28052.

Improving the M. C. B. Coupler. Gives the full report of the committee appointed by the Western Ry. Club; also the views of Mr. John Hickey. Ill. 3000 w. Ry Age—May 26, 1899. No. 27905.

Proposed New Contour Lines and New Specifications for M. C. B. Couplers. Abstract of committee report presented at the annual convention of the Master Car Builders' Assn. at Old Point Comfort, Va., June, 1899, with editorial. Ill. 5000 w. Eng News—June 22, 1899. No. 28214.

Some Notes on the M. C. B. Coupler. Gustave Giroux. Suggestions as to methods of strengthening it. 2700 w. Ry Mas Mech—June, 1899. No. 28146.

The Car Coupler Problem. Points out some of the reasons for the rupture of coupler heads and stems, the rapid destruction of the wearing parts, etc., believing accidents are chiefly due to curable conditions of impact and draft. 1800 w. R R Car Jour—June, 1899. No. 28061.

The M. C. B. Coupler. John Hickey. A communication making a reply in part to the comments on the writer's report of Jan. 19, 1899, relative to automatic link and pin couplers versus M. C. B. type. 1800 w. R R Car Jour—June, 1899. No. 28062.

Electric Locomotives.

See Electrical Engineering, Power Applications.

Exhaust Nozzle.

A New Locomotive Exhaust Nozzle. Data regarding tests made at the University of Illinois, of locomotive exhaust nozzles, comparing the action of a new nozzle, designed by Don Sweney, with the Smith triple-expansion nozzle and several round nozzles. 2200 w. R R Gaz—June 16, 1899. No. 28142.

Large Cars.

Canda's 100,000 Lbs. Capacity Cars. Illustrates designs of a box car, a double hopper bottom coal car, and a truck for use under cars intended to carry loads of 100,000 pounds, on the Southern Pacific R. R. 3800 w. R R Gaz—June 9, 1899. No. 28051.

100,000 Pound Hopper Car, Norfolk & Western Railway Company. Illustrated description of a plain strong construction intended for hard service. 600 w. R R Car Jour—June, 1899. No. 28063.

Locomotives.

American Locomotives for Foreign Railways. Detailed information, with illustrations, showing the great extent to which American locomotives are now used, with editorial discussion of the general causes which have led to their export. 6000 w. Eng News—June 15, 1899. No. 28104.

Compound Locomotives. Francis William Webb. Read before the Engng. Conference of the British Inst. of Civ Engs. An explanation of the system of compounding used by the author, reporting the economy of pull due to compounding to be 19 to 20 per cent. 1800 w. Engng—June 9, 1899. No. 28183 A.

Coupled Express Locomotive for the Palatinate Railways (Locomotive Express Accouplés des Chemins de Fer du Palatinat). F. Barbier. With plate of sections and details, and computations of tractive power. 2000 w. 1 plate. Le Génie Civil—May 27, 1899. No. 28304 D.

Economics of Freight Locomotive Operation. G. R. Henderson. Gives data which point to the conclusion that ten miles is the most economical speed on parts of the road not level, but that on level stretches the speed can be varied. 1800 w. Am Engr & R R Jour—June, 1899. No. 27925 C.

English and American Locomotive Building. Charles Rous-Marten. A timely discussion of the causes which have led to the placing of extensive orders in the United States for locomotives for British railways. 4000 w. Engineering Magazine—July, 1899. No. 28380 B.

Express Passenger Locomotive for the London and South-Western Railway. Illustrated description and particulars. 700 w. Engng—June 16, 1899. No. 28270 A.

Flanged Tires for Mogul, Ten-Wheel and Consolidation Locomotives. Abstract of a committee report presented at the annual convention of the Am. Ry. Mas. Mchs.' Assn., at Old Pont Comfort, Va., June, 1899. 1200 w. Eng News—June 22, 1899. No. 28210.

Locomotive Progress. A review of recent development and improvement in design. 1800 w. Ry Mas Mech—June, 1899. No. 28145.

Notes on the Effect of Ports and Valve Gears on the Performance of High Speed Locomotives. R. A. Smart. Shows the importance of careful attention to the design and construction of valve gears and ports, and the effect on the capacity of the locomotive at high speeds. 800 w. Am Engr & R R Jour—June, 1899. No. 27927 C.

Old and New Belgian Express Locomotives. Engravings showing two very different types designed for the same service, with a brief account of the performance of the improved machine. 400 w. Loc Engng—June, 1899. No. 27907 C.

Parallel in the Development of the Locomotive and Electric Car Truck. John A. Brill. Illustrated account showing a remarkable and interesting parallel in the successive steps by which the development has progressed. 1500 w. Ry Wld—June 8, 1899. No. 28223 D.

Powerful 8-Wheel Passenger Locomotives—Chicago & Northwestern Railway. Illustrations and full description of these fast-mail locomotives. 700 w. Am Engr & R R Jour—June, 1899. No. 27921 C.

Standard Consolidation Freight Locomotives—Pennsylvania Railroad. Illustrated detailed description of the heavy freight engines, classes H5 and H6. 4000 w. Am Engr & R R Jour—June, 1899. No. 27919 C.

The Atlantic Type and the Wide Firebox. J. Snowden Bell. Calls attention to the special capabilities and advantages of this type of engine in connection with the use of the wide firebox. 2300 w. Am Engr & R R Jour—June, 1899. No. 27926 C.

The Determination of the Friction Losses of Locomotives. W. F. M. Goss. Extract from an article published in the Purdue University *Exponent*. Gives data seeming to show a loss in draw-bar pull due to engine friction of about 500 pounds, or about 67 horse-power, with

the locomotive running at 50 miles per hour. 2000 w. R R Gaz—June 9, 1899. No. 28055.

The Development of the Tank Locomotive. Arthur E. Kyffin. An illustrated review of various types of tank locomotives, with interesting data. 3000 w. Mech Wld—June 9, 1899. Serial. 1st part. No. 28167 A.

The Simple and Compound Consolidation Locomotives of the Atchison, Topeka & Santa Fe. An account, with illustrations, of the tandem compound and the simple engines, with data from careful service tests extending over several months. 4400 w. R R Gaz—June 16, 1899. No. 28140.

Motor Cars.

Steam Motor Cars for Branch Lines. Illustrated description of a car constructed by the Baldwin Locomotive Works for the Cincinnati, Hamilton & Dayton Railroad. 700 w. Sci Am—June 24, 1899. No. 28200.

Passenger Cars.

New Bogie Carriages. Illustrates and describes some bogie composite corridor lavatory carriages being constructed for English railways. 500 w. Engr, Lond—June 2, 1899. No. 28089 A.

Piston Valves.

Piston Valves for Locomotives. F. M. Whyte. On the application of piston valves to locomotives, the use of packing rings, effect on balancing, etc. Ill., 2700 w. Am Engr & R R Jour—June, 1899. No. 27923 C.

Reports.

Reports to the Master Mechanics' Association. Abstracts of reports presented by the various committees of the American Railway Master Mechanics' Association, at the convention in Old Point Comfort, Va. 12500 w. R R Gaz—June 23, 1899. No. 28225.

Sleeping Cars.

The International Sleeping Car Company of Europe. E. G. An account of the operations of this company, the growth and present extent, with interesting particulars of the service rendered. 1700 w. R R Gaz—June 9, 1899. No. 28056.

Valve Gear.

Positive-Motion Corliss Valve Gear (Zwangläufige Corlissteuerungen). H. Dubbel. A Corliss valve gear without trip motion, arranged especially for locomotives. Data of tests are given showing the economy of a locomotive with this gear over the slide valve. Two articles, 7000 w. Zeitschr d Ver Deutscher Ing—June 10, 17, 1899. No. 28323 each D.

Vestibules.

The Vestibule Car. Arthur H. Giles. Illustrates and describes various forms, comprising the most important inventions in vestibules and vestibule cars. 1000 w. R R Car Jour—June, 1899. No. 28064.

Wheels.

Car-Wheel Construction. Edward Grafstrom. Gives a method of analyzing the stresses in a wheel. Ill. 2800 w. Am Engr & R. R. Jour—June, 1899. No. 27922 C.

NEW PROJECTS.

Argentina.

Light Railways in Argentina. A general report of the light railways and the laws relating to them. 500 w. U S Cons Repts, No. 451—June 14, 1899. No. 28100 D.

China.

New Chinese Railway from Canton to Hankow. A general outline of the work, furnished by William Barclay Parsons, who had charge of the surveys. 1000 w. Eng News—June 1[illegible] 1899. No. 28105.

The Hankow-Canton Railroad. Interesting information concerning the line recently surveyed by William Barclay Parsons, known as the "Brice Concession." 1200 w. R R Gaz—June 16, 1899. No. 28141.

India.

Indian Railway Extension. On the evidences of recent progress, the new lines opened, their cost, etc. 2000 w. Engr, Lond—May 26, 1899. No. 28009 A.

Mexico.

Railway Construction in Mexico. Reports an interview with John P. Ramsey, general manager of the Rio Grande, Sierra Madre & Pacific Railroad. 1500 w. U S Cons Repts, No. 451—June 14, 1899. No. 28098 D.

Peru.

Proposed Railway in Peru. Translation of a government decree under which bids are invited for the construction of a line from Oroya to Cerro de Pasco. 1400 w. U S Cons Repts, No. 452—June 15, 1899. No. 28119 D.

Switzerland.

American Capital in Swiss Railways. Information concerning existing roads, railways projected and in course of construction, concessions, etc. 2200 w. U S Cons Repts, No. 455—June 19, 1899. No. 28166 D.

Uruguay.

The Railways of Uruguay. Reliable information concerning the railways, their operation and financial condition. 1800 w. U S Cons Repts, No. 456—June 20, 1899. No. 28173 D.

Venezuela.

Railway Contract in Venezuela. Translation of a recent concession for the construction of a road between Puerto Cabello and Yaritagua. 1200 w. U S Cons Repts, No. 453—June 16, 1899. No. 28135 D.

PERMANENT WAY AND FIXTURES.

Culverts.

Comparison of Cost and Efficiency of Various Styles of Small Railway Culverts. Hunter McDonald. Part of a paper read before the Engng. Assn. of the South. The different materials used are reviewed, and the construction discussed. 3000 w. Ry & Engng Rev—June 3, 1899. No. 28021.

Hamburg.

The Rearrangement of the Railway Terminal at Hamburg (Die Ungestaltung der Eisenbahn-Anlagen in Hamburg). With a plan showing the improved arrangement of tracks, stations and warehouses to be used in connection with the harbor traffic. Two articles. 1 plate. 6000 w. Deutsche Bauzeitung—May 13, 20, 1899. No. 28351 each B.

Signalling.

Electro-Pneumatic Signalling Plant. Illustrates and describes an interesting signalling plant recently carried out for the Great Eastern Railway Co., of England. 2500 w. Engng—June 16, 1899. No. 28271 A.

Sleepers.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Walter W. Curtis. Report of the author's investigations to determine the value of the treatment, with a résumé of knowledge on this subject. 19000 w. Pro Am Soc of Civ Engs—April, 1899. No. 28117 E.

The Use of Beech Wood for Railway Sleepers (Ueber Verwendung von Buchenholz zu Eisenbahnschwellen). A paper by Ober-Baurath Wetz before the German Railway Association, with discussion, mainly concerning the best method of preserving such sleepers from decay. 6000 w. Glaser's Annalen—May 15, 1899. No. 28346 D.

Station.

Improvement of the Grand Central Station, New York. Describes and illustrates plans for the construction of a large waiting room for the use of all divisions, changes in the trainshed, and other improvements, all of which must be carried out without interrupting the immense traffic. 2300 w. R R Gaz—June 23, 1899. No. 28226.

Remodeling the Grand Central Station, New York. Illustrated description of the improvements to be made, with details of the iron construction. 2000 w. Eng Rec—June 17, 1899. No. 28164.

The Enlargement of the Waverley Station, Edinburgh. From the *Scotsman*. Extract from an interesting account describing the remodelling of the North British Co.'s Waverley Station at Edinburgh, 1200 w. Transport—May 26, 1899. No. 27995 A.

The Reconstruction of the Main Station of the Vienna Municipal Railway (Umbau und Neubau des Hauptzollamts-Bahnhofes der Wiener Stadtbahn). A. Oelwein. With details of bridge and elevated railway construction and plans of station and approaches. 5000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—June 9, 1899. No. 28332 B.

Terminal.

The New Terminal Station of the Orleans Railway (La Nouvelle Gare Terminus de la Cie d'Orleans). An illustrated account of the progress of the work upon this new terminal in Paris, showing the present condition of the work on the Quai d'Orsay. 3500 w. Le Génie Civil—June 10, 1899. No. 28306 D.

Transition Curves.

See Civil Engineering, Measurement.

TRAFFIC.

Railway Operation.

Some Principles Governing the Proper Distribution of Locomotives in Economical Railway Operation. E. M. Herr. Notes the points to be studied to secure the proper distribution of power. 1500 w. Am Engr & R R Jour—June, 1899. No. 27924 C.

STREET AND ELECTRIC TRAMWAYS

Amiens.

The Electric Tramway of Amiens (Les Tramways Electriques d'Amiens). With illustrations of the power plant, the overhead conductors and the cars, and a general description of the installation. 1500 w. L'Electricien—May 13, 1899. No. 28372 B.

Conductors.

Overhead Conductors for Electric Railways (Die Oberleitung Elektrischer Strassenbahnen). Max Schiemann. A very complete discussion of the best methods of constructing overhead trolley lines, including the trolleys and communication to the cars, as well as the sup-

port and arrangement of the conductors. Two papers, 10000 w. Elektrotech Zeitschr—May 11, 18, 1899. No. 28353 each B.

Contact System.

The Diatto System at Tours (Das Diatto-System in Tours). Giving a section of the conduit and showing how the contact is made with the moving car. 1500 w. Elektrotech Zeitschr—June 8, 1899. No. 28362 B.

The Diatto System of Electric Traction. From *La Vie Scientifique.* Illustrates and describes the system as operated at Tours, France. 1700 w. Engr, Lond—May 26, 1899. No. 28012 A.

The Tramways of Tours (Les Tramways de Tours). J. A. Montpellier. A fully illustrated account of the installation of the Diatto contact system of electric traction at Tours, with map of the tramway system. 2500 w. L'Electricien—April 29, 1899. No. 28368 B.

Cross-Country.

An Interesting Cross-Country Electric Road. Illustrated description of the tramway from Dayton to Eaton, Ohio. 1000 w. St Ry Jour—June, 1899. No. 27948 D.

Dundee.

Dundee Tramways. Report of E. Manville to the tramway committee of the corporation of Dundee, on the proposed extensions, and other changes under consideration. 7000 w. Elec Eng, Lond—June 16, 1899. No. 28250 A.

Electric Locomotives.

See Electrical Engineering, Power Applications.

Electric Railways.

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